JOINT THEATER MISSILE DEFENSE
AN ARMY ASSESSMENT

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

STEVE ZAPPALLA, MAJ, USA
B.S., United States Military Academy, West Point, NY, 1981

Fort Leavenworth, Kansas
1993

REPORT DO..JMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	4 June 1993	1 Aug 92-4June 93

4. TITLE AND SUBTITLE
Joint Theater Missile Defense (JTMD):
An Army Assessment

5. FUNDING NUMBERS

6. AUTHOR(S)

Major Steve Zappalla

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Command and General Staff College
Attn: ATZL-SWD-GD
Ft. Leavenworth, Kansas 66027-6900

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This study is a strategic analysis of the Army's ability to perform the Joint Theater Missle Defense, (JTMD), mission. The need to protect against the short range theater ballistic missile threat is a rapidly growing problem. The assessment and analysis provided in this study identifies capabilities needed to improve or maintain Army ability in this mission. Additionally, this analysis reveals issues that effect the overall military JTMD capability, in light of sililar service roles and responsibilities.

The assessment is made by evaluating Army capability in each of the four JTMD mission areas: active defense, attack operations, passive defense, and command, control, communications and intelligence. The adequacy of each of the four mission areas is determined by analyzing effectiveness of current doctrine, training, leadership, organizational, and material systems (DTLOM criteria) that support each of the four Army JTMD missions. Evidence gathered leads to assessments concerning the readiness of the criteria so that in turn judgements can be drawn concerning capability in each of the four areas. Areas not fully validated are identified for further investigation.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Air defense, theater missile, missile defense, joint theater missile, ballistic missile defense	115
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	

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Fort Leavenworth, Kansas
1993

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of candidate: Steve Zappalla, Maj, USA

Thesis Title: Joint Theater Missile Defense (JTMD): An Army Assessment

Approved by:

John A. Reichley, Thesis Committee Chairman
Mr. John A. Reichley, MBA, MSJ, M.Ed.

Chester L. Smith, Member, Second Reader
LTC Chester L. Smith, M.Ed.

Gerald W. McLaughlin, Member, Consulting Faculty
Colonel Gerald W. McLaughlin, Ph.D.

Accepted this 4th day of June 1993 by:

Philip J. Brookes, Director, Graduate Degree Programs
Philip J. Brookes, Ph.D.

The opinions and conclusions expressed herin are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other government agency. (References to this study should include the foregoing statement.)

ABSTRACT

JOINT THEATER MISSILE DEFENSE (JTMD): AN ARMY ASSESSMENT, by Major Steve Zappalla, USA, 116 pages.

This study is a strategic analysis of the Army's ability to perform the Joint Theater Missile Defense, (JTMD), mission. The need to protect against the short range theater ballistic missile threat is a rapidly growing problem. The assessment and analysis provided in this study identifies the capabilities needed to improve or maintain the Army's overall ability in this mission. Additionally, this analysis reveals issues that effect the overall military JTMD capability, in light of similar service roles and capabilities.

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ACKNOWLEDGMENTS

In all sincerity, this thesis would not have been possible without the help of a few people I have come to know better and respect more. If I did not recognize the efforts and personal time sacrificed by my thesis committee and family, I would be terribly wrong. So here goes....

First of all I thank **Mr. John Reichley**. His mentorship was key to completing this project and provided the motivation needed to keep things moving. Without his overall support this effort would not have been possible. My thanks to **LTC Chester Smith** for his never-ending suggestions and his efforts to keep me "straight", and to **COL Gerald McLaughlin** for setting this thesis in motion and helping me to pull it all together.

Next I thank my wife **Allyne**, my children **Kristen, Lisa, Jennifer, Stephanie, Angela and Dominic** for providing the "balance" needed to help keep things in perspective throughout this project.

And finally, yes I will thank my mom. I'm not a world renowned author yet, but it's a start. I think your spelling lessons finally paid off. "Hey Ma how do you spell...," reply: **"Look it up in the dictionary"**. "Com'on Ma...". Well maybe I should wait until you read the paper. The initiative, determination, patience, and common sense you taught me once again helped me to accomplish yet another difficult task. I also thank you for editing and for letting me use your computer.

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CHAPTER ONE

INTRODUCTION

> Saddam himself once told me they (Scuds) were nonsense, just something that makes a hole in the ground. Political missiles can trigger a misguided demonstration, but they can never win a war.[1]
>
> Hosni Mubarak
> President, Egypt

This document examines the Army's ability to conduct Joint Theater Missile Defense (JTMD). It assesses doctrine, material, training, organizational and leadership systems critical to the performance of JTMD missions. The analysis of these systems helps determine the Army's overall capability to perform JTMD activities as part of the United States armed forces. This thesis answers the question: How well can the United States Army perform the JTMD mission? The model, criteria, and references used to answer this question are outlined in chapter two. Chapter three outlines the operational environment, mission requirements, and threat information needed to analyze the information provided in chapter four while the final chapter provides a summary, judgements, and areas for future study.

Purpose and Structure

It does not take long to realize nor is it easy to ignore, the significant threat currently faced from ballistic missiles. A brief look at the current ballistic missile environment serves to introduce the need and purpose of the JTMD mission. This section also details the structure of this thesis.

In undeveloped theaters the proliferation of ballistic missiles in the Third World poses a new challenge to policy makers. Many Third World countries either have Cruise missiles or are trying, usually in a covert manner, to develop or acquire them. Current trends suggest that the number of countries with a theater missile (TM) capability will continue to increase.[2] **The impact of this proliferation is significant.** Many US friends and allies, as well as current or potential political, economic, or military adversaries will, in the future, be vulnerable to missile attack from many developing nations. The quantity of missiles and their possible use are also considerations. Missile-capable nations may not need to use large numbers of missiles to cause dramatic political change in a region, for the mere threat or subsequent use of a single weapon may be sufficient to achieve a regional goal. Some of the threats that The US can expect and must contend with includes

intentional missile attack as part of a regional campaign to seize, control, and/or defend territory; limited attack of population centers or critical assets to achieve political benefits; denial of merchant shipping freedom of navigation through waters outside of internationally recognized territorial limits; and unauthorized/accidental launch of missiles.

In addition to the greater quantity of missiles, the current trend is toward longer range missiles with increased accuracy, greater penetration, and more lethal warheads to include chemical, biological, and possibly nuclear capabilities. These improved systems will pose an even more challenging and serious military threat in the future. Ground, sea, and air launched missiles, continue to proliferate and grow in sophistication. These weapons have been exported to more than 70 nations around the world and the next generation of missiles will be available to export customers by the late 1990s.[3] In developed theaters a more significant threat to the US and its allies is posed by countries who have qualitatively advanced missiles in great quantity. JTMD capabilities must be structured to meet this threat and should be able to cope with theater missile (TM) threats in any contingency operation, and be suitable for rapid deployment. The threat is further detailed, developed and discussed in chapter three.

JTMD Missions

The purpose of JTMD is to defend against TM attack, as developed above, through an integrated and coordinated mix of four mutually supporting measures.[4] These four measures of defense, also known as the JTMD pillars, are **active defense, attack operations, passive defense, and command, control, communications, and intelligence** (C^3I) (Sometimes computers are added, forming the acronym C^4I). This thesis assesses Army JTMD capability by analyzing each of the four mission areas. The specific functions related to each of the missions make up the complete JTMD mission and all current development of JTMD systems fall into these four areas. **Active defense** measures deal with striking air threats in flight while **attack operations** involve striking TM targets on the ground. **Passive defense** measures involve deception techniques, cover and concealment, and other methods while C^3I involves all command, control, and intelligence systems used to pull the entire TMD mission together.

Each of these four mission areas is assessed by evaluating specific criteria that must be in place and functional to insure that the mission area is effective. The variety of functions and procedures associated with material systems (actual hardware), doctrine and tactics, training proficiency, personnel and organizations, and leadership abilities unique to each individual JTMD mission area must be

assessed as adequate for the mission area to be effective. These criteria, identified as DTLOM, (Doctrine, Training, Leadership, Organizations and Material) are the model used to assess the JTMD missions.

The analysis is conducted through a search for observations, in respect to each of the four mission areas, to provide the evidence needed to show adequacy of a DTLOM area. In this manner conclusions concerning the effectiveness, readiness, and overall capability for a mission area will be apparent. In turn, analysis of these four missions together provides the basis for understanding the Army's complete JTMD capability.

In addition to providing an overall assessment this paper must address several related questions to adequately answer the primary purpose and associated research question. These questions are presented to help understand the overall analysis of Army JTMD assessment. The order of analysis for these questions relates to the structure for this paper. Before assessing the Army's capability we must first fully identify what capability the Army has to perform this mission. What mission has the Army been given and what part of the total JTMD mission is it? Where did the mission come from and how was it developed? Must the Army have to respond to other services or coordinate with them to perform JTMD? If so, to what degree, and how does it affect its ability?

Are there other systems from other services that affect the Army's ability to perform JTMD? Once these questions are addressed capabilities can be compared to requirements.

Background and Scope

Some JTMD critics argue that ballistic missiles are "just another target or target set" and therefore the mission can be added to a system that already exists without having to waste resources on developing a "new" system. However, what they fail to realize is how different this target set is and what our capability really is in this area. This target set flies; it is highly mobile, difficult to detect and, most of all, extremely destructive. This section provides a brief history leading to our current situation, assumptions, anticipated problems, limitations, and the importance of this research.

Protection of US citizens, military personnel, and US interests from the devastating effects of short and long range missiles is a growing problem for the US. Only until recently has the US begun to more closely examine the need for an improved defense system to counter both long and short range missile attacks. Recent developments and funding, such as those associated with the current Strategic Defense Initiative (SDI) program have focused on the long range missile threat.

The SDI or "Star Wars" program developed during the 1980's played a significant role in concentrating efforts toward the protection of the United States against long range intercontinental ballistic missiles. Significant resources were expended to develop near term technologies and concepts to support global and national missile defense needs. Concerned that the increasing production and nuclear capability of the Soviet Union far exceeded the capability of current defenses, the US developed a concept using both ground and space based systems against missiles directed toward the United States.[5] The system consisted of several ground and space based subsystems that improved the ability to detect, track, and destroy intercontinental ballistic missiles.

However, the long range missile threat was not the only missile threat that the US faced. Although most of the intercontinental threat was limited to the Soviet Union, Third World countries had made significant improvements in their short range missile capabilities. While not a direct threat to the continent (except in limited areas), they posed a significant threat to US personnel and interests abroad. Believing that these capable missiles would be used against the US if provoked a need to provide for some type of defense in a theater of operations was realized. Until 1990, the only real means of protection against short range missiles

was to find and destroy them on the ground through a variety of different weapon systems or to protect our assets through passive means as much as cover, concealment, and deception. The US needed a system that would destroy short range ballistic missiles while in flight.

In conjunction with developing technologies as part of the SDI program and improving current capabilities of Army ground to air, air defense (AD) systems, the US Army took the lead to develop anti-ballistic missile defense systems. The Army's Air Defense Artillery (ADA) branch was assigned the ballistic missile defense mission in 1978.[6] The term ballistic missile defense was later changed to tactical missile defense and then theater missile defense or TMD.[7] The ADA school, under the Training and Doctrine Command (TRADOC), took on the role of the combat developer or user responsible for defining requirements and determining priorities. Shortly thereafter the Army, through the AD school was tasked as the leading service to monitor, manage, and track the development of short range missile defense systems.

The AD branch was responsible as the combat developer for ballistic missile defense but had to rely on other Army and Defense level organizations responsible for complete system architecture and most of the technological developments and funding for these programs. The major

player was the SDI program managed by the Office of the Secretary of Defense (OSD) under the Strategic Defense Initiative Office (SDIO). In 1991, SDI became Global Protection Against Limited Strike (GPALS).[8] The GPALS mission has three areas; national missile defense (NMD), global missile defense (GMD), and the one presented in this thesis, theater missile defense (TMD).

The products and systems associated with each of these three missions are in varying stages of research and development. Some products from one mission also fall within another mission area. This thesis focuses on the TMD mission, which deals with the short range ballistic missile, those with a range of less than 600 nautical miles. National missile defense and global missile defense are for greater distances.[9] TMD will be referred to as joint TMD or JTMD. TMD in a theater of operations will always be joint, involving more then one military service, and are identified as JTMD in all doctrinal publications.

The general nature and large scope of the JTMD mission has an impact on each of the services' mission areas. The Army, Air Force, Navy and, to a lesser extent, the Marines have all established organizations designed to develop TMD weapon and control systems for their respective areas of ground, sea, and air based platforms including space based considerations. This paper analyzes the Army's ability to

perform the TMD mission and may help provide insight for the continued development of the GPALS program in general.

Additionally, the assessment of TMD capability within the Army is an important step in resolving the concerns and challenges confronted by the GPALS program today. Is GPALS legitimate in light of the changing world situation and threat? How much should be invested in a system that may not be needed? If this program is to survive, an overriding requirement and need must be identified. Furthermore, in times of reduced resources it may be necessary to reduce duplication and specify the optimal method to develop and deploy JTMD assets among the services. An evaluation of the Army's current capabilities identifies its potential for continued application of the TMD mission and delineates future roles and missions among the services.

Assumptions

Four assumptions are made in this thesis. First, funding will be available to continue to improve or maintain the capabilities identified in the analysis portion of each of the four JTMD mission areas. Without funding the analysis of a particular capability will change. Second, that the Army AD branch will remain an Army asset. Studies have considered eliminating the AD branch or giving much of its current capability to the Air Force. Although the Army would continue to have a significant capability in the attack

operations mission of JTMD, the Army would loose its entire ability in the active defense role, attacking missiles in flight. Third, JTMD will remain a valid mission for the joint force as a whole. However, this work still provides a studied solution and assessment of the Army's capability which identifies what is needed to bring the Army back to a higher level of capability. And finally, to insure that the Army can perform the four JTMD missions, ratings are derived based on the assumption that the mission cannot be performed. The search for observations and evidence provides the basis for the DTLOM rating and mission analysis. If there is no evidence to support a rating, then this study assumes the Army cannot accomplish the mission.

Importance

In addition to the importance of the research outlined above, this thesis will be one of the first to consolidate the capabilities of the Army for each of the TMD pillars. The JTMD mission cuts across almost all the Army's mission areas. Each branch in the Army is responsible for some portion of the JTMD mission, yet no one document pulls together or identifies the capabilities and limitations across the Army as a whole. The information contained in this paper will be useful as a source reference document.

This document can also be used to help determine a future role of the Army in TMD and the relationship it should

have with other services in support of the TMD mission. Once compared to the capability of another service, this paper may suggest that one service is better suited than another to perform the entire JTMD mission by itself. Analysis may also show that different parts of the JTMD mission may be better performed by different services, or that each service should have the capability to perform some portion of the JTMD mission.

CHAPTER TWO

LITERATURE REVIEW AND DESIGN

Now having a better feel for the nature of this topic, a brief review of the sources of information gives even further insight into the diversity of JTMD. The second section of this chapter details the model categories and criteria used to assess Army capabilities in the JTMD mission.

Literature Review

Most of the literature used to research material programs being developed by the Army to perform JTMD is taken from program reviews and documents provided by the Joint Theater Missile Defense Project Office (JTMDPO) at Redstone Arsenal in Huntsville, Alabama. Along with the TRADOC centers and schools the JTMDPO provided most of the information concerning hardware capabilities and system characteristics. These were helpful in providing an assessment of current Army capabilities and the status of ongoing combat developments. The primary source for researching Army requirements in the JTMD mission have been

joint publications and Army and other service field manuals. These documents, although some are only in draft, have provided the majority of the definitions and understanding of what the Army is required to do compared against actual capabilities as presented in chapter three.

Although the joint publications are published by the joint staff for adherence by all services, not all service manuals reflect the terms and guidelines published in the joint publications. The relatively new Air Force (AF) manual AFM1-1 does not define JTMD missions in the same light as the Army. Current multi-service doctrine publications, service doctrinal manuals, and OSD and service requirement for JTMD development were also used to define and analyze the Army JTMD mission. Additionally , each services' TMD organization for ground, sea, air, and space based efforts have helped to further examine service unique requirements. CINCSPACE publications were a good source of detailing joint responsibilities for JTMD.

In addition, the following Army and OSD organizations and their subordinate elements have been a major source of literature and research information in support of this paper: Strategic Army Defense Command, SDIO, TRADOC headquarters staff and schools, involved in TMD mission areas, Army Space Command, CINCSPACE staff, Air Ground Operations School, Air Land Forces Agency (ALFA), DA staff (DAMO-FD, force

development), AMC labs involved in TMD development, (MICOM, CECOM), and PEO structure. These organizations provided some feedback and data concerning the "true" effectiveness of the individual JTMD programs and systems.

The remainder of the data concerning JTMD effectiveness used in the analysis came from unclassified results and analysis of recent JTMD exercises (ULCHI FOCUS and TORPID SUNSET) and lessons learned from Desert Shield/Storm. The TMD data search provided extensive information and insight into the various aspects of TMD operations during Desert Shield and Desert Storm.

Information was acquired regarding all four principal areas of TMD operations. The best documented area was that of active defense; lessons learned information in this area was very specific and tied directly to the subject of TMD. The other areas related less directly to the subject of TMD. For example, in attack operations, problems involved with targeting and bomb damage assessment were often the same for Scud associated targets as for many other battlefield targets. Similarly, intelligence gathering problems for Scud activities were, in many ways, the same as for other strategic targets. The data sources which documented problems and recommended corrective action often did so without reference to specific supported activities such as Scud searching and attack operations. These instances

required some subjective judgement as to whether they were applicable to TMD.

Research and coordination for this thesis began in September 1992. Much of the information used was gathered and developed from January 1990 to June 1992 while the author served as a TRADOC joint doctrine and combat development staff officer and a participant during Operation Desert Storm, working for the ARCENT G-3. A majority of the information gathered from 1990-1992 related directly to the development of the Army's role and mission in theater missile and air defense. Commands and activities consulted during the course of this research are listed in the bibliography. In addition to a wealth of data and information gathered from the listed offices, a majority of the information referenced came from the Joint Universal Lessons Learned System Reports, JULLS, on Operation Desert Shield/Storm as compiled and submitted by U.S. Central Command (248 reports extracted and reviewed).

Research Design

This strategic analysis is accomplished in three steps. First, as already noted, this thesis develops the need and Army requirement for JTMD. Step two further describes the evidence in terms of systems and programs available to accomplish the requirements. And finally, step

three provides specific conclusions concerning the comparison of requirements and analysis and how this information may be useful.

Research design develops the model and associated criteria used for the assessment. The four areas: active defense; attack operations; passive defense measures and command, control, communications, and intelligence (C^3I); will be analyzed and evaluated separately. Once the assessment of these areas is complete they can then be viewed as a complete system for evaluation of the Army's overall JTMD capabilities. These categories are evaluated by presenting doctrine, training, leadership, organizational, and material systems (DTLOM) available to perform the missions associated with each of the four JTMD categories. These areas are further referred to as the criteria for assessment. The degree of completeness or readiness of each of these criteria will show how well each of the four JTMD missions can be performed.

These five criteria come from a system used by the Army to develop solutions to problem areas or battlefield deficiencies.[10] The system, known as the concept based requirement system (CBRS), will be modified to serve as the model for this assessment, with a modification. Instead of using this model to develop solutions, it will be used to see if the developed solutions for each of the criteria have

actually demonstrated effective ability. Instead of developing doctrine, training, leadership, organizations, and material (DTLOM) systems and procedures to develop a capability, this thesis will look at the evidence that systems and procedures can be expected to fix or maintain a certain capability in each of the DTLOM areas.

By looking at these criteria within each of the JTMD mission areas the documented effectiveness of the Army to accomplish the JTMD mission will become apparent. For example, the Army developed Patriot which directly relates to the "material criteria" in DTLOM to accomplish the active defense portion of the JTMD mission. Patriot, therefore, was developed in response to an Army inability to protect itself against missile attacks, a battlefield deficiency.

Ratings

In each section in chapter four dealing with each of the four JTMD mission areas an overall rating will be given for that mission area as justified in that section according to readiness of DTLOM areas. Each criteria associated with a particular JTMD mission area will be rated as C1, C2, C3, or C4. A C1 rating means there are few to no deficiencies and all systems are in place. All documentation and expectations have been met with little to no ongoing work is needed or being performed. A C2 rating indicates that there is evidence that the system is being worked on, however it is

still acceptable at this time. Here, existing systems need improvements or modification. A C3 indicates serious problems with a particular system and no evidence exists to show that solutions are being pursued. Major overhauls and rework must be completed for that system to be effective. A C4 rating indicates there is no evidence the system is functioning. The critical requirements expected of that system have failed and little to no value of producing any positive capability can be expected. In turn, these ratings, as supported by evidence and analysis, provides information needed to develop an individual assessment for each of the mission areas. Evidence provided leads to conclusions and indications concerning how well the missions can be accomplished and the degree of work needed to maintain or improve the adequacy of that mission. Although ratings are subjective to some degree, quality and quantity of evidence provided allows the reader to draw personal conclusions otherwise not made by the author.

CHAPTER THREE

OPERATIONAL ENVIRONMENT

As you may begin to see JTMD is a very diverse mission which makes it difficult to manage. Because the mission covers a wide range of tasks and impacts several different missions it is truly a challenging task to control and completely understand. The US role, Army mission requirements, and expected theater missile threat relate directly to the information presented and continues to provide a common understanding of categories, criteria, and terms used as the basis for analysis in this chapter.

National Role

A discussion of the operational environment includes the US role as a world leader, the concept of global force protection, and joint and combined operations (operations with other countries). The US is a full partner and leader in a world which continues to evolve into different geopolitical entities. This nation has faced and will continue to face increasingly complex and unpredictable situations where US vital interests are at stake.

Historically, the US has evolved a national security strategy of working closely with allies and other friendly nations by building coalitions to protect shared interests. In an era of increasing potential for regional conflict, the military instrument of power will continue to be a key part of US national security strategy.

Due to this dynamic world situation, regional commanders in chief (CINCs) and their staffs face many challenges which place significant demands on their ability to project military power throughout the world. TMs is one of these challenges that poses a threat to US security interests. The precise time, location, and nature of a given threat will often be uncertain, thus complicating the process of determining force composition and method of power projection to overcome specific threats. Because the global nature of US interests requires that forces be capable of providing TM defense worldwide rapidly, from the US or from forward bases and ships, CINCs must plan for contingencies to conduct opposed force entry by land, sea, and/or air in defense of national interests.

Enemy TMs are also a threat to allied nations and coalition interests and forces. Though JTMD assets are limited, national and military strategy may also require defending selected theater strategic geopolitical assets. The focus for JTMD in the operational environment is

twofold. First, JTMD must be capable of countering threats consisting of missile systems and associated C^3I, targeting, and logistical support systems. Second, JTMD in undeveloped theaters requires systems be capable of rapid global deployability and intratheater mobility.[11] The objectives of JTMD are to:

1. Prevent the launch of TMs against US forces, US allies, and other important countries, including areas of vital interest.

2. Protect US forces, US allies, other important countries, and areas of vital interest from TMs launched against them.

3. Reduce the probability of and to minimize the effects of damage caused by a TM attack.

4. Detect and target TM platforms; to detect, warn, and report any TM launch; and to coordinate a multifaceted response to a TM attack and to integrate it with other combat operations.[12]

The term "**theater missile**" applies to ballistic missiles, air to surface guided missiles, and air, land, and sea launched Cruise missiles whose target is within a given theater or which are capable of attacking targets within a given theater. The term "**theater missile defense**" applies to the integration of joint and national capabilities to detect and destroy enemy missiles and aircraft armed with air-to-surface missiles before launch, in flight, or on the ground; to destroy enemy theater missile C^2 and logistic centers, or otherwise disrupt hostile TM operations through an appropriate mix of mutually supportive passive missile

defenses, active missile defenses, attack operations, and supporting command, control, communications, and intelligence (C^3I) measures. The term **"theater missile defense systems"** applies to the combination of systems supporting passive and active missile defense measures, attack capabilities, and the C^3I support and countermeasures required to counter the missile threat.[13] With the Third World TM capability growing the US must reaffirm its commitment to the development of JTMD systems that comply with existing arms control agreements and policy.

Missile systems with ranges greater than those which are constrained by the Intermediate-Range Nuclear Force Treaty (ranges between 500 and 5500 kilometers) are known to be in the inventory of several Third World nations. TM attacks could be launched concurrently from many directions, and may require defense systems to have a capability for 360 degree coverage.[14] Moreover, Third World countries view ballistic missiles as a form of strategic deterrence and some nations believe that ballistic missiles are militarily and politically effective weapons.

The complex requirements involved in defending against the TM threat require a highly coordinated and integrated effort of all national assets to be effective. Additionally, allied capabilities in each of the four JTMD mission areas must be integrated to obtain the maximum effectiveness in

countering enemy TM's. The ability to coordinate these actions is challenging. Requirements, responsibilities, and organizational considerations for conducting JTMD in a combined operations environment are similar to joint operations. Because each theater and each country is unique special considerations and areas of emphasis are needed. Even within formal alliances, there are varying national interests which should be identified and considered. Differences in doctrine, training, equipment, and organization must be identified and conside' l when determining alliance interoperability requirements for employing forces. Consensus on the enemy TM threat, a clearly defined chain of command, and a responsive, interoperable command and control structure are all crucial to successful combined JTMD operations.

Mission Requirements

A single capability cannot provide complete protection against a determined TM attack. A mix of passive and active counters to the total array of enemy TM systems is required. Such a mix is provided by the four JTMD missions. Once battlefield deficiencies are realized and concepts and thoughts concerning JTMD are approved as doctrine, systems and programs are developed to meet the requirements imposed through doctrine. The doctrinal concepts established to

perform each of the four JTMD mission areas are discussed in this section.

Active Missile Defense

The role of active missile defense is to engage incoming TMs in flight for the protection of selected assets and forces from attack. This includes attack of air-to-surface missiles, anti-ship missiles, Cruise missiles, and the attack of aircraft equipped with missiles, as early as possible during the course of the flight trajectory to reduce collateral damage to ground assets. To create a coherent TM defense, active missile defense operations must be complemented by passive missile defense and attack operations.[15] Active missile defense can be highly effective, but for the foreseeable future cannot be expected to provide an impenetrable shield.

Active missile defense operations defend only what is most important or critical due to resource limitations and accepts some risk should the enemy attack lower priority assets which are not directly defended. The principal contributors to active missile defense operations include surface-to-air missile and gun systems, and aircraft primarily engaging enemy airborne launch platforms.

Command and control has a major impact on the active defense mission. In accordance with established doctrine and procedures, the joint force commander through his area air

defense commander (AADC) will exercise control of Army surface-to-air AD assets for active missile defense air operations.[16] A confirmed launch triggers reaction by a preplanned selection of appropriate defensive systems. Short missile flight times require that all applicable air, land, sea, and space based sensor and surveillance assets be integrated to provide a complete and current air picture. Active missile defense C^3I must use the existing air defense C^3I structure.

Active missile defense planning begins with intelligence preparation of the battlefield (IPB). Intelligence capabilities are identified and designated for TM detection while threat priorities and rules of engagement (ROE) are established for engaging both enemy aircraft and missiles. Army AD units are designated to protect critical points or areas of the theater. An enemy launch observed and identified through national, operational, or tactical surveillance systems triggers near real time active missile defense and attack operations, along with initiating passive missile defensive actions by military units and civilian authorities.

Attack Operations

Attack operations include offensive actions taken to destroy enemy missile assets on the ground. The detection, acquisition, identification, and attack tasks are highly

dependent on an instantaneous C^3I process and rapid targeting capability.[17] Attack operations are challenging because TM systems are generally hard to detect since they will normally be dispersed, mobile, electronically quiet, and redundant. The objectives of attack operations are to reduce or deter enemy use of TMs, increase the survivability of maneuver forces, reduce political impacts, and minimize the effect on friendly combat capabilities.

Attack operations are highly dependent on predictive and developed intelligence. Because it may be difficult to detect highly mobile launch systems, a C^3I capability must exist to support near real time targeting and attack. National sensor systems will be required to augment theater air, space, and ground-based systems. Currently, a wide variety of munitions is available to provide the means to concentrate combat power against deployed enemy TM systems. Attack assets include all services' tactical air support; ground maneuver, to include Army attack helicopters; artillery cannons, rockets, and missiles; naval surface fire systems and submarine-launched weapons; and direct action by special operations forces. Nonlethal measures, such as electronic warfare, may also be used against enemy TM systems.

A great deal of fire support capabilities comes from Army field artillery, ground maneuver, aviation, intelligence

and electronic warfare (IEW), and special operating forces (SOF). The Army field artillery plays a significant role in attack operations. JTMD attack operations are part of field artillery counterfires, interdiction, and joint fire support operations. Counterfires are an integral part of the maneuver commander's OPLAN/OPORD and the joint force commander's (JFC's) JTMD plans. As part of the JTMD scheme of operations, ground maneuver forces (armor, infantry, Army aviation, and airborne) may be employed to support JTMD attack operations. Aviation contributes to JTMD offensive actions by conducting attack, air assault, and reconnaissance operations in support of interdiction and joint fire support. Electronic warfare (EW) can contribute to attack operations through EW support measures and electronic countermeasures. As strategic assets, selected SOF elements may be deployed to the theater and placed under the operational control of the joint force commander. SOF may support attack operations through direct action, special reconnaissance and target designation for other fire support delivery means. In addition, psychological operations may be conducted to multiply the effects of attacks on enemy TM assets by driving home their vulnerability and susceptibility.

Conduct of attack operations requires sensor systems, responsive near real time sensor management and

communications network, and weapons systems capable of attacking targets as soon as adequate targeting information is available. At the tactical level, responsive intelligence and operations interfaces are required for targeting and countering the mobile enemy missiles. Once hostilities are initiated, all targets acquired are attacked in accordance with the JFC's guidance. Attacking launch platforms as early as possible prevents the launch of a substantial number of TMs. The Army's ability to integrate and perform these functions defines the Army's future role for JTMD.

Passive Missile Defense

The objective of passive missile defense is to degrade the enemy's ability to target US and host nation/allied forces and facilities, reduce vulnerability and increase survivability to attack, and provide for reconstitution and recovery of forces.[18] Passive missile defense measures are a cost effective and timely way to provide protection for friendly forces and facilities. By examining various combinations of warhead accuracy and effects, numbers of available missiles, and the enemy targeting process, the time and likelihood of attack may be predicted and passive measures chosen for employment before, during, and after a TM attack.

Tactical warning of incoming missiles is a passive defense measure as well as is reducing enemy targeting

effectiveness through operations security (OPSEC) and deception. Communications security, and signature reduction through the use of camouflage, commonality of vehicle appearance, emission control programs for infrared and electromagnetic emissions, and cover and concealment all help to deny enemy timely acquisition and identification of friendly targets.[19] In addition, local unit security denies accurate targeting data to enemy special operations forces or other enemy agents. Frequent movement of units is of singular importance.

Deception is a very effective passive measure. Misleading the enemy by manipulating, distorting, or falsifying friendly actions causes the enemy to deplete his TM resources by attacking false targets, missing intended targets, and denying him accurate battle damage assessments. Deception influences enemy decision makers by feeding intelligence collectors what appears to be credible information. Deception includes provisions for protecting resources vulnerable to TM attack. Passive defense comes in other forms as well.

Reducing vulnerability through hardening, decoys, dispersal, training, and recovery operations is effective. Hardening reduces the effect of attack on systems such as aircraft, air base support equipment and facilities, nuclear delivery systems, nuclear storage areas, C^2 elements,

communications nodes, and theater logistic facilities. Protection for mobile ground forces and equipment may be best accomplished by careful site selection, field fortification, and other field-expedient methods. Decoys can also help preserve the force by simulating capabilities. Activities suitable for replication by decoys include such things as C^2 nodes, ground stations for airborne sensors, air defense sites, logistic sites, and forward area arming and refueling points. Bogus radio nets and traffic can also be used as a deceptive measure to mislead the enemy about the locations of critical nodes. Dispersal, another passive missile defense method, can help to reduce target vulnerability by increasing the difficulty of attack. Another measure, often forgotten, is training civilian authorities in the Army. Civilian authorities should be trained to organize and instruct their populations on actions to take on warning of a missile attack. This training can help to reduce the political impact of missiles hitting civilian areas/facilities.

Although command and control is presented as a separate JTMD mission its requirements impact on each of the other three missions, therefore its unique doctrinal impact is presented in respect to the mission being described. The principal C^3I impact on passive missile defense measures is space-based warning information fed by USCINCSPACE. To enhance tactical warning capabilities, the warning net must

link with space-, air-, and surface-based sensors (both national and theater) that detect missile launches or track missiles in flight. Regardless of the time available, warning is essential to allow for the use of all possible protective measures for exposed personnel and equipment.

Planning for passive missile defense measures is conducted at all levels. Integration of the planning process reduces the effectiveness of the threat by establishing and communicating the actions to be taken at each level of command. Executing passive defense measures is the responsibility of unit commanders at each echelon. Effective communications must provide the information required at each level to support the execution of passive missile defense plans.

Command, Control, Communications, and Intelligence (C^3I)

Command and control for JTMD operations is the exercise of authority and direction by commanders over forces assigned JTMD tasks. JTMD C^3I functions are performed through an arrangement of personnel, equipment, communications, facilities, databases, and procedures designed for planning, directing, coordinating, and controlling forces to accomplish JTMD.[20] The C^3I system links passive and active missile defense and attack capabilities to provide timely assessment of the threat, rapid dissemination of tactical warning, targeting data, and mission assignment and post strike

assessments to the appropriate JTMD element. In addition to the C^3I requirements listed in each of the pillars already presented, C^3I should fulfill the following basic requirements for each of the JTMD pillars:

> Passive missile defense measures require predicting and detecting a launch, predicting the launch and impact points, providing threat identification (chemical, biological, nuclear, or conventional) and timely warning.
>
> Active missile defense requires early detection of missiles in flight to permit cuing, acquisition, tracking, identification, and destruction soon after launch.
>
> Attack operations require accurate location of launch platforms and support systems and timely transmission of targeting data to attack systems.[21]

To ensure synergism, C^3I planning for active missile defense and attack operations must be coordinated among all components of the force on a continuous basis. Planning considerations for C^3I must also consider both joint and combined relationships. The diverse nature of each of the four JTMD missions makes coordination critical. JTMD elements need to complement each other due to the possible impact of JTMD on other missions and tasks.

The intelligence function is carried out through a dispersed network in which national and service systems are interconnected. Though the functional systems (sensors, decision support/fusion centers, and firing units) may be dissimilar, interoperable communications will allow them to operate most effectively. During operations, the C^3I

system must rapidly disseminate intelligence to each of the services for rapid targeting capability, and C^3I for JTMD actions needs to be integrated into the overall theater communications network. Service organizations conducting JTMD actions need to maintain an interface with and be interoperable with the other components' organizations. Ideally, while enemy missiles are in flight, updated enemy launch locations and target data base information are passed to the appropriate command and control and offensive systems (Army Tactical Missile System (ATACMS), Multiple Launch Rocket System (MLRS), air assets, and Army AD assets) and launch warnings are provided to all units/commands within the theater.

Threat

The Iran-Iraq War demonstrated that Iraq could readily obtain large supplies of missiles and replace expended inventories. At the start of the war in 1980, Iraq was reported to have only twelve Scud-B launchers and probably no more than 100 missiles. Yet, during the Iran-Iraq War, Iraq fired at least 300 Scud type missiles at ranges in excess of 600 km's.[22] It was evident that Iraq had a greater capability than originally thought. Cities and population centers were terrorized. This caused Iran to adjust, alter, and reconsider its defense plans.

The military effectiveness of ballistic missiles depends on technical and operational characteristics. An understanding of enemy missile doctrine and capabilities helps to improve our missile defense design plan. Most important are range, accuracy, and warhead type, but also significant is the volume of sustained fire. A longer range missile can enhance operational flexibility. A missile with short range that has to be fired from launch sites in forward positions is more vulnerable to enemy counter-strikes, while a missile with a longer range can be fired from deep inside friendly territory, complicating the enemy's task of locating the missile launchers. All Scud type ballistic missiles fired by the Iraqis during Desert Storm were fired at a range of 575- 620 kilometers from their intended targets.[23]

Accuracy may not matter very much in the attack of area targets or military installations spread over large areas (such as an equipment storage site) or heavily populated urban centers. If it is possible to fire large numbers of missiles at the same target, reduced accuracy can be acceptable. A missile with a chemical weapons payload fired at an area target, such as a city or an air base, may not need to be very accurate. The Scud missile and its Iraqi variants incorporated 1950s and 1960s guidance technology and are relatively inaccurate. Estimates of the circular error probable (CEP) for Iraqi Scuds, fired at maximum range, vary

between 1000 and 2000 meters depending on which Scud variant is fired.[24]

The destructiveness of a missile depends in part on the warhead it carries. The Iraqi Scuds were fitted with relatively small warheads weighing 500 kilograms, of that, only 300 kilograms were devoted to carrying high explosives. By comparison, this is a fraction of the payload typically carried by modern attack aircraft.[25] The payload capability of a single F-16 aircraft is approximately equal to that of four Scud missiles. All Scuds fired during Desert storm were armed with unitary warheads consisting of conventional high explosives. Chemical and biological weapons, though threatened, were never employed. At the outset of the Gulf War, Iraq was assessed as having chemical and biological weapons.

The effectiveness of missile attacks also depends on the number of missiles that can be fired within a short period of time. Although a large number of missiles was fired during the course of the Iran-Iraq War, neither country was able to fire significant quantities in a short period of time. Launcher availability, missile inventories, and firing preparations are the primary determinants for ballistic missile volume of fire. During that war, the Iraqis never fired more than eleven missiles in one day, and they never fired more than seven missiles during any 12-hour period.

The impact of limited inventories and slow tempo of fire is evident in the experience of Iraqi air and missile forces during the 1988 "War of the Cities." Between February 29 and March 14, 1988, the Iraqis claimed that they fired sixty-eight Al-Hussein missiles at Iranian cities.[26] The collective weight of the explosives carried by these missiles amounted to less than thirteen tons, although this significancly understates the net destructive effect of the missiles; the missile body and unexpended fuel add considerable destructive force on impact. During the same period, the Iraqi Air Force was able to drop 731 bombs weighing just under 314 tons on Iranian cities.[27]

During Desert Storm the highest volume of fire was achieved on January 25, when eight Scuds were launched against Israel and two against Saudi Arabia. By the end of January, Scud launchings diminished, with the high figure of four in one day during February.[28] Although there were considerable unknowns concerning the original Iraqi launcher and missile order of battle during Operation Desert Storm, fixed and mobile launchers had to be found. Fixed sites are usually easier to detect and subsequently destroyed while the operating tactics for mobile launchers were designed to minimize the vulnerability of the missile force by denying precise locations needed to aid in the destruction of the missiles.

Use of hide-positions and rapid redeployment made detection difficult. Iraqi mobile missile launcher crews used terrain, good use of employment, concealment, and launch preparations for protection before, during, and after an attack. Specific procedures and plans were in place and practiced to minimize potential destruction from enemy forces. The Iraqi's extreme concern for detection was seen by its refusal to use easily spotable meteorological data gathering equipment in support of launches.

A review of Scud launches throughout Desert Storm showed an Iraqi pattern of launching the modified Scud only to a specific range. There did not seem to be any flexibility in the ability to adjust the range of the missile being fired. Following strikes by coalition air forces in the second week of the war, the Iraqis began using new launch sites for many of their launches.[29] Most general information available shows that Scuds launched during the first week of the war were fired from similar ranges and from sites near major roads. This practice restricted launch site options and allowed coalition air forces flying over the known launch areas during the second week of the war to be relatively successful in denying their use.

Iraqi response included a significantly reduced number of launches against the primary targets of Dhahran and Riyadh, Saudi Arabia, Haifa, and central Tel Aviv, Israel.

switching to new launch locations which were about 600 kilometers from the new targets such as Bahrain and the Saudi locations of Al Jubayl and areas near Hafar al Batin, Iraq launched some missiles to slightly longer ranges (600-620 kilometers) and accepted an apparent significant decrease in accuracy and effectiveness.[30] There were many shots in the general direction of Tel Aviv subsequent to January 26; a few of these hit the city's eastern or northern suburbs while others impacted at various locations in the Israeli and West Bank countryside. One possible explanation for the range inflexibility is that the Iraqis lacked the training and firing tables to properly adjust the range of the modified Scud. Virtually all Scud firings took place at night or during times of poor visibility. The majority occurred between sunset and sunrise.

Chemical and biological weapons, though threatened, were never employed. Despite most expectations, Iraq did not use chemical weapons against Israel. It is possible this was deterred by the prospect of Israeli nuclear retaliation. In the Gulf War, Iraqi Scud missiles launched against Israel and Saudi Arabia posed a political threat to the US-led Coalition. As terror weapons, the Scuds threatened to draw Israel into the war and to divide the US-led Coalition. Had the Patriot anti-missile system and Army doctrine, tactics, leadership, and training not been available to protect

against Iraqi Scud strikes, attacks on Israeli civilians may have compelled Israel to retaliate. Potentially, the outcome of the Gulf War could have been far different had the rapid deployment of Patriot defenses to Israel not encouraged Israel to refrain from retaliating against Iraq.

In general, because Iraqi Scuds were inaccurate and employed only conventional warheads, they were considered to pose a negligible direct military threat. Nevertheless, Iraqi Scud strikes did have a significant indirect military effect on Coalition efforts. They caused a considerable diversion of allied military attention and resources because allied troops, and Saudi and Israeli civilians, had to be prepared for a chemical attack, and because an unexpectedly large portion of allied air operations was directed toward the difficult task of finding and destroying Scud sites. Air Force Chief of Staff General Merrill McPeak observed in this regard, "We thought from the beginning that we would have to attack Scuds. What surprised us was that we put three times the effort than we thought we would on this job.... We had some obstacles to overcome.... We worked around the diversion of a significant portion of our combat power on the Scud problem."[31]

The Patriot-Scud duels over the skies of Saudi Arabia and Israel foreshadowed the importance of ballistic missile defense capabilities for the future. The Scud attacks in the

Gulf War, however, offer only a modest taste of the threat likely to be posed by ballistic missiles in the 1990s and early 21st century. Had Iraq had missiles with greater range and accuracy, as expected to spread to the Third World in coming years, it could have directly threatened the homelands of the major Coalition partners and in turn have had a great coercive power against these countries. Limited defense systems such as Patriot could not have countered such a threat.

The proliferation of ballistic missiles and weapons of mass destruction has been a continuing trend since the mid-1970s in Third World countries. While the Gulf War demonstrated the impact of missiles as terror weapons, it did not demonstrate the much greater impact on activities that sophisticated, long-range missiles armed with weapons of mass destruction will pose to the US and its allies in the future. More than twenty countries have or are trying to acquire ballistic missiles. At least fifteen have operational missile forces. By the year 2000, twenty-four or more Third World countries could have ballistic missile capabilities. A few can produce missiles indigenously now. At least fifteen countries could be able to build ballistic missiles indigenously by the year 2000.[32] Others could purchase missiles on the international market. The countries with ballistic missile programs can be found in all major

regions of the world. The most critical regions are the Middle East, South Asia, East Asia, and South America.

Ballistic missiles in the Third World are typically deployed with mobile launch vehicles to reduce vulnerability to enemy attack. As the US discovered in the Gulf War, finding the fixed missile launchers is relatively easy, but finding the mobile launchers is extremely difficult. Because of the mobility of Iraqi missiles, US strike aircraft flew many sorties that otherwise could have been directed against other critical targets. Despite the considerable effort devoted to Scud destruction, Iraq still managed to fire at least eighty-six missiles, and retained a significant portion of its Scud force throughout the war.

In the foreseeable future a relatively large number of countries will acquire ballistic missiles and weapons of mass destruction. Some will also acquire access to space reconnaissance data and space technologies for surveillance and targeting. As a result, regional conflicts will become vastly more destructive, fast-paced, and geographically broader in scope. The spread of such weapons has the potential to upset regional military balances and create fears of surprise attack that could exacerbate crises. Proliferation during the 1990s will lead to an unprecedented condition in numbers of countries armed with ballistic missiles and weapons of mass destruction.

CHAPTER FOUR

ANALYSIS

Up to this point in the thesis the Army's role in JTMD has been looked at in terms of doctrine and it's responsibility in the context of the military environment. Now, an analysis of the specific Army systems and their capabilities aid in assessing the Army's specific JTMD capability. Each of the following sections examines one of the four JTMD mission areas in respect to DTLOM evaluation criteria. Some of the observations impact more then one DTLOM area and in some cases more then one mission area, therefore, the same observation may be justification for an assessment in other areas. Some observations and evidence provided could also pertain to missions other than JTMD keeping in mind that all observations are considered when evaluating the adequacy of a particular area.

Active Defense

The active defense mission area ratings below are developed and analyzed in this section.

	DOCT	TNG	LDSHP	ORGAN	MATERIAL
ACTIVE DEFENSE	C3	C3	C3	C2	C2

The Army Patriot system was the only means of providing active ballistic missile defense during operation Desert Shield/Storm. As a result of a briefing concerning the status of air defense and TMD for operation "Internal Look 90" in July 1990, the Deputy Commander-in-Chief (DCINC), US Central Command (USCENTCOM), decided that the Patriot should receive increased priority for integration into the USCENTCOM time phased force deployment list (TPFDL).[33] A total of twenty-nine Patriot batteries were employed; twenty-one in Saudi Arabia, six in Israel (four US and two Israeli Defense Force batteries), and two in Turkey.[34] The Patriot system was originally designed as a weapon to counter high speed, high performance aircraft; however, its software and missile capabilities were changed to a now intercept and destruction of incoming Scud missiles five months earlier than scheduled. The system was upgraded several times from August 1990 and upgraded periodically during the course of operations in the Gulf. Although software improvements were

in general considered a success, in some cases software upgrades applied during Operation Desert Storm undermined operators' confidence in their weapon system. This is seen as a training and leadership weakness.

On eighty-six occasions, Iraq launched Scuds: forty times against targets in Israel and forty-six times against targets in Saudi Arabia. Of these, fifty-three Scuds came within Patriot coverage areas in Israel and Saudi Arabia.[35] The rest fell beyond Patriot range or harmlessly into empty desert or the sea. The Patriot air defense missile system intercepted a high percentage of engageable Scud missiles; however, some of the warheads were not destroyed and missile debris fell on populated areas. One of the reasons was revealed as a complication of the Patriot system. In space, the Defense Satellite Program (DSP) detected five missile launches, but by the time the Scuds reentered the atmosphere at a speed of 4000 miles per hour, the five missiles had broken into fourteen missile parts, including five warheads. The Patriot responded by firing twenty-eight missiles.[36] This was an impressive reaction but it raised concerns regarding the capability to sustain that rate of fire with available missile supplies.

Nonetheless, the Patriot system proved to be an effective counter to Iraqi Scud attacks on innocent civilians, boosting civilian morale and enhancing Coalition

cohesion. Without them, and without close communications established between the US and Israel during the war, Israel might have retaliated against Iraq, thereby stressing the Coalition's political unity. All indications were that Patriot was very successful at intercepting the majority of Scud missiles within its engagement envelope. Although a mission success occurs if the system diverts the incoming missile and prevents it from hitting a defended asset, the diversion of the missile and/or warhead into other friendly areas could cause unwanted casualties and a perception of Patriot failure.

Since Operation Desert Storm ended Patriot critics have come forward with dissenting positions regarding its success. Many Israelis believed Patriot would be a source of absolute protection against attacks.[37] It was not understood that Patriot was designed to defend small point assets and not vast populated area targets. For Israelis, the standard of success was quite different; they expected destruction of all warheads and fragments from missiles, and contended the Patriot didn't provide that. A fifty-two page critical analysis was published by Harvard University in the professional journal International Security. The author, Theodore A. Postol, a Massachusetts Institute of Technology physicist, had once served as a science advisor in the Pentagon. He stated, "Our first wartime experience with TBM

defenses resulted in what may well have been a nearly total failure to intercept quite primitive attacking missiles."[38] Israeli scientists and military officers said their own postwar studies concluded that Patriots had destroyed less than twenty percent of warheads bound for Israeli targets. Stanford University Professor William J. Perry, Under Secretary of Defense for Research and Engineering during the Carter Administration and now co-director of Stanford University's Center for International Security and Arms Control, took a more moderate view on the issue. He said that the Patriot did as well as could be expected, but that better defenses of the future had to pay "serious attention" to the problem of decoys.[39]

Raytheon Corporation (Patriot primary contractor), in a twenty-eight page rebuttal of Postol's allegations, highlighted the Patriot's contribution to the alliance. Robert M. Stein, manager of Raytheon's advanced air defense programs, observed that the Patriot's performance could be "measured" by the fact that the Coalition "did not falter."[40] Israel stayed out of the war, and widespread loss of civilian life was not inflicted, although the potential was clearly there. Stein conceded the difficulties of building an impenetrable shield. He said, "We as designers and manufacturers of these systems wish we knew how to achieve a 100 percent success rate under all conditions in

wartime; we do not."[41] Perhaps the debate can best be summed up in the words of a July 1991 Report to Congress by the Secretary of Defense which stated, "The political significance of the Patriot in assisting with the defense of Saudi Arabia and in frustrating Saddam's most politically visible weapon was enormous."[42]

Availability and correctness of active defense doctrine is an area that must be addressed. Current efforts center on several unresolved issues related to doctrine. Most significant is that there is a valid need for TMD coverage at some levels of command, most likely at corps and echelons above corps, and that service roles and responsibilities for TMD be established. Some actions underway now to improve doctrine include an approved TMD master plan that explains responsibility for each of the four mission areas and the development of the Army's TMD battlefield concept.[43]

The employment of Patriot fire units in Israel exceeded doctrinal norms to accomplish national strategic and political goals. As part of the active defense mission Patriot fire units were deployed to protect a very diverse combination of both national (strategic) and military (tactical) assets such as airfields, cities, breaching operations, logistics bases, oil fields, and maneuver divisions. The size of the defended assets varied from very

small (Safwan Airfield) to very large (Riyadh and Tel Aviv). However, Patriot units are designed to provide limited point defense against theater ballistic missiles. The presumed Iraqi objective was to prompt independent Israeli military action, divert the attention of the international community, and initiate an Arab-Israeli conflict to splinter the Coalition arrayed against Iraq.[44] To thwart Iraqi intentions, US National Command Authority (NCA) deployed Patriot fire units to Israel to provide limited theater missile defense. In Israel, single fire units were defending entire cities even though Patriot is designed to fight best when all battalion assets are integrated into the defense design. Optimal system performance was circumvented. Furthermore, the training required for Patriot's newly developed missile defense role must be improved. The operator actions and planning considerations for the TMD role is different than for aircraft. All personnel must be familiar with the full range of tactics to be employed in ballistic missile defense. Army doctrine is not yet adequate and service roles and missions are confusing. OSD is currently studying new Army and service TMD requirements.

The Iraqi-Israeli threat to US national security strategy and interests in the Persian Gulf helped establish the importance of air defense artillery units in the active defense role. This requirement for ADA further highlights

the need for doctrine development and subsequent material, organization, material, and leadership systems needed to implement this type of deployment. In formulating future national security strategy air defense units capable of countering TMs provide political leadership another vehicle to accomplish strategic objectives. ADA doctrine should include crisis response capability to support contingency operations rapidly, in sufficient strength, and with improved area defense anti-missile capabilities to support the national strategy.

The US Army Air Defense Artillery School is struggling to develop this significant shortcoming in doctrine and the subsequent material and training issues regarding Patriot operations. These missions were never envisioned as a Patriot responsibility, and took the 11th ADA Brigade beyond the bounds of current doctrine and system capabilities.[45] The geopolitical nature of this mission and the success enjoyed by air defense forces in fulfilling this mission have set the stage for similar missions to be assigned to air defense forces in the future. In this regard, the Army must prepare for missions that go beyond tactical and operational levels. Air defense forces must be capable of defending theater strategic area targets in contingency operations. In the near-term, this will require expansion of current Patriot capabilities through radar, missile, and software upgrades.

The long term implications of assuming this mission will be the development of newer, more sophisticated, and longer range air defense systems.

Active defense doctrine, organizations, training and leadership systems need to be developed for the use of an ADA task force. AD task forces are organized by combining different AD weapon systems in one battalion to perform the same general mission. AD planning failed to adequately consider the equipment, personnel, and combat service support implications when fighting as an ADA task force and task force training and doctrine was not adequate prior to Desert Shield/Desert Storm. When an air defense task force was deployed the headquarters was often not staffed with the proper mix of personnel. Decisions were difficult because the task force concept was relatively new.[46] Lack of training, organization, and doctrine contributed to the difficulties experienced by the task forces in command and control, employment, and combat service support. Here, training

improvements must be made, doctrine validated, and organizations formed. Requirements for operation and maintenance are not yet defined and developed.

Other significant Patriot peculiar observations were experienced in obtaining authorization to occupy terrain critical to conducting the active defense mission. The ADA

brigade headquarters coordinated with corps and division staffs for terrain to emplace fire units in both corps sectors. On several occasions, units were directed to relocate and coordinate with maneuver brigades and battalions for terrain but the alternate locations did not always allow optimum coverage of the defended assets. Leadership, doctrine, and training effectiveness were adversely affected because of this. Corps commanders must consider the air and ballistic missile threat when prioritizing the use of terrain in their sector. Proper positioning of air defense weapons is critical to achieving maximum weapon capability.

It is also evident that doctrine and material developments will help improve the Army early warning system needed to accomplish the active defense mission. Operation Desert Storm highlighted the need for timely, accurate early warning of theater ballistic missile launches. Improved early warning provides increased flexibility of Patriot units, ensures maximum system readiness, and allows units to plan time needed for other activities, such as maintenance. Although an ad hoc early warning system was developed for Operation Desert Storm and was to some degree successful, it took time to develop and is not yet formalized as Army ADA doctrine. Little to no joint training for the use of this early warning equipment had been conducted prior to Desert Shield. Required equipment to support early warning should

be assigned to Patriot battalions, and unit personnel need to be trained on this equipment prior to deployment in a hostile situation.

Improvements in joint training and an organic capability that allows Army air defense to interface with the Air Force in undeveloped theaters is needed. In a developed theater, Army air defense is set up to coordinate with the Air Force command center which orchestrates air defense execution for the air component. In an undeveloped theater the Army currently has no organic capability to integrate and interface with the theater air defense structure. During the Gulf War, prototype data interface devices were fielded as an interim solution to provide interface with AWACS. The Army decision was to fund the Joint Tactical Information Distribution System (JTIDS) at a minimum level.[47] JTIDS will provide an organic air defense interface capability with the Air Force when the system is fielded; until then, Army air defense operations in an underdeveloped theater are at risk. Improvements in doctrine and materiel through a joint air defense and airspace management plan could be made if integrated into operational plans and exercised regularly. Theater air defense electronic equipment could then be exercised and tested prior to unit deployments to ensure full connectivity among all services.

Additionally, the lack of joint training prior to

Desert Shield/Storm resulted in delays in preparedness to fight jointly. At the onset of Desert Shield, deployed Patriot units knew relatively little about Air Force air defense operations. Conversely, the controlling Air Force units knew little about Patriot capabilities, or how to maximize their effectiveness. This resulted in considerable training time before Air Force and Patriot units were ready to fight together. ADA personnel should receive extensive training in ballistic missile engagement procedures. Joint training and exercises are essential to achieve a high level of mutual understanding among air defense and Air Force units.

Doctrine fixes should be made based on the need to deploy air defense forces early for successful protection of contingency missions. As the Army moves from reliance on forward deployed forces toward a CONUS (continental US) based force projection mission, the need for ADA protection of contingency lodgements increases. An ADA brigade should be one of the first deployed elements as it must defend the lodgement airheads, ports, and combat generating units. It should also defend corps assembly areas until organic corps ADA units arrive in the theater. Patriot deployment considerations must also be studied and formalized. The transportation assets used for deploying the 11th ADA Brigade (210 aircraft sorties and twenty-three ship loads) severely

taxed the US transportation system. It required seventy-three C-5 sorties, 123 C-141 sorties, fourteen commercial reserve Air Fleet sorties, and twenty-three ships to deploy the 11th ADA Brigade for operations in the Gulf.[48] Because the 11th ADA Brigade was not fully integrated into the time phased force deployment list (TPFDL) in time for deployment precluded total reliance on the use of surface means of transportation. Here, leadership issues, training systems, and doctrine development are needed to help alleviate this problem.

The need for increased coverage has increased the need for pursuit of material advances by the Army. The Army is examining potential upgrades to current air defense systems, potential new corps air defense systems, and expanded air defense protection for theater assets is currently underway. Formalized requirements now include capabilities in many different areas that will make target acquisition, identification, and intercept more reliable. Actions are underway by the Patriot project manager to identify technology to fit the requirement.

The Patriot PEO cited the need for a data recorder in the system to provide timely responses to unanticipated threat variations, environmental conditions, or other phenomena not yet available.[49] Data is needed for post mission analysis and to facilitate tactics and training

refinements. A mission data recorder was used in operations conducted in Israel and proved necessary to optimize the Patriot missile system's capability against theater ballistic missiles. Using portable data recorders and video cameras in the units' engagement control stations (ECS) and information and coordination central (ICC), analysts reviewed system data and crew switch actions. Detailed crew debriefs permitted units to respond quickly to changes in threat mission profiles or performance and served as a starting point for the revision of tactics, techniques, and procedures used in subsequent TBM engagements. Furthermore, engineers identified and implemented modifications to the system's software, thereby improving weapon performance. Although in-place organization, training, and material systems exist to assist in this area, improvements may be realized if each Patriot C2 element (ECS and ICC) had an embedded mission data recorder to record both system and operator actions.

Material, leadership, and training shortfalls were seen through the identification of many logistics and maintenance shortfalls. Some of the catastrophic failures of the Patriot 150 KW/400 HZ generators were attributed to running the system with a heavy load over prolonged periods. The power from these generators was essential to the operation of the Patriot radar and fire control systems and there is no alternate source of power. Other problem areas

associated with generator failures included lack of maintenance, lack of quality deficiency reports, vendor support, depot overhaul procedures, and lack of critical spare parts.

Patriot electric power plants malfunctioned at a rate much higher than expected. The 150-KW electric power plant (EPP) generator caused major problems. In Saudi Arabia, generators ran continuously, and EPP's failed.[50] The company that built the EPP was no longer in business; therefore, engines that required major repair were returned to depot for rebuild. Experience shows that the EPP, as configured during Desert Storm, was inadequate. The EPP should be evaluated in a realistic combat environment as to its suitability for further use.

There were a number of logistics problems in support of the Patriot system. There were critical Patriot system repair parts shortages at the national inventory control point. The authorized stockage list (ASL) stockage levels were inadequate for the increased level of operations experienced in Southwest Asia. Transportation bottlenecks inhibited the flow of Patriot items and severe backlogs at Army depot points, logistics aircraft, and in-country break bulk points were created. Dedicated air transportation of critical class IX repair parts is a doctrine issue that must be examined. The theater Army material management center

(TAMMC) was late arriving in Saudi Arabia and its procedures were inadequate.[51] Items were lost in backlogs and Patriot system parts were given little priority. The supply system for all classes did not work well for Patriot units. Throughout their time in theater, Patriot units also experienced problems with class II and V, frequently being forced to scrounge, beg, and borrow from neighboring units to get what was needed to operate. Most detrimental to combat capability, however, were the problems with class IX. Some battalions turned in more than 2,000 requisitions and never saw a single part through normal supply channels. Organization and leadership deficiencies must be overcome for the supply system to be effective. Leaders should ensure stocks are up to authorized levels before deployment and, once in a new theater, commanders and staffs must establish reliable procedures for all classes of supply. Doctrine and organizations should be developed to help alleviate this problem.

Security of active defense forces is another area that must be incorporated into doctrine and training systems. An augmentation of fifteen to eighteen infantry trained personnel was required to protect and provide ground security for each Patriot battery. Batteries, especially in a ballistic missile defense posture, are emplaced in a widely disbursed configuration, which renders a Patriot battery

highly vulnerable to enemy ground attack. The 24-hour requirements of the Patriot battery's mission and support functions occupy fully all authorized personnel; this results in insufficient capability to protect the relatively large perimeter from ground attack. To compensate for this shortfall during Desert Storm, a fifteen to eighteen man security augmentation was provided to each Patriot battery. In light of the fact that Patriot batteries are easily identifiable, are very lucrative targets, and do not have requisite manpower, a security augmentation should be considered into organizations and training by the leadership when the batteries are vulnerable to ground attack. This is especially important for the protection of Patriot batteries when deployed in an active defense role to counter enemy missiles.

The Army's ability to reduce the chance of fratricide must also be improved in all DTLOM systems. Proper evaluation of targets is an insurance against fratricide and must continue to be an important consideration. Interrogation Friend or Foe (IFF) systems and reaction to all types of ECM systems must continue to be pursued. The Army's recently developed fratricide prevention plan is now being implemented.[52] It addresses steps and measures by DTLOM to help reduce the potential of a fratricide problem. Much effort has been given to examine steps in each of the DTLOM

areas instead of just looking for material developments. Radar-directed air defense systems that may be deployed in close proximity to systems from other services should participate in joint testing and training for realistic ECM training.

Attack Operations

As detailed earlier the conduct of attack operations is highly reliant on adequate sensor systems, responsive communication networks, and a weapon system capable of attacking targets at their origin. Current Army capabilities to execute the full range of attack operations are limited due to problems associated with finding and acquiring missile launch platforms, supporting command and control, missile transfer and transportation, and support bases.

	DOCT	TNG	LDSHP	ORGAN	MATERIAL
ATTACK OPNS	C3	C2	C3	C2	C2

Because Coalition airpower played a large role in

attack operations against Iraqi theater missile activities, its basic deployment should be looked at to understand the complete attack operations scenario and capability. Virtually every type of aircraft operated by the Army, Navy, Air Force, and Marine Corps took part in Operation Desert Storm. These aircraft, both fixed and rotary wing, delivered a wide variety of munitions, many of which were precision guided. More than Over 100,000 combat missions were flown against Iraq by fixed-wing aircraft.[53] Air operations strategy was to paralyze Iraqi ability to operate offensively or defensively, to destroy the Iraqi capability to threaten the security and stability of the region, to render Iraqi forces in the Kuwaiti Theater of Operations (KTO) ineffective as a fighting force, and to minimize Coalition and Iraqi civilian casualties. The highest initial priorities were to establish air supremacy by eliminating the Iraqi integrated air defense system, to render enemy air forces ineffective, and to prevent Iraqi use of chemical and biological weapons.[54] Follow-on strikes were conducted against each target set until the desired objective for each was obtained. By the third day of air operations, attacks had begun on ballistic missile production and storage capability.[55] As the Iraqis began launching Scuds from their mobile systems, Coalition strategy shifted to finding and destroying the mobile launchers. Several "Scud boxes"

were designated to help narrow the search for the elusive targets that would emerge from hiding. The campaign was intense and ran throughout the war.[56]

Problems in locating Scud launch sites and obtaining damage assessment contribute to much of the Army's limitations in performing attack operations. Defining Army capability in this area is largely determined by capability needed to overcome or improve identified limitations. Despite the many extraordinary measures taken, the difficulty in finding mobile Scud launchers was never satisfactorily resolved, and ongoing Scud attacks continued to absorb resources. Although all fixed and bermed Scud sites were destroyed, finding and destroying Iraq's mobile launchers proved a difficult problem, diverting resources from other aspects of the operation. It also prolonging the threat to Israeli, Saudi, and other civil and military targets throughout the region.

Locating and destroying targets on the ground required large amounts of Army resources and time not normally afforded by the procedures set up to target suspected areas. C^3I nodes had to be hit on several occasions to make them inoperative. To ensure that all aspects of targeting receives the widest review, targeting boards, within and outside the Army, must be emphasized. Prioritizing targets for destruction was not a joint effort. The implication for

leadership, doctrine, and training is that directions with respect to targeting need to be provided to all involved in the process. Procedures should be instituted to support CINC and service targeting priorities and have representatives for each of the services available on a regular basis.

Prior to Desert Storm, service targeting sections supported the ATO development as supported by doctrine. However, during Desert Storm numerous ad hoc groups (within the services, joint headquarters and nationally) were formed causing competition for information and duplication of effort. The result was identification of invalid targets, incorrect target names, and incorrect coordinates. Organization and training systems within the Army were weak in this area. The Army should develop its role in the targeting process and internalize it. Proper use of a trained and effective targeting support system is strongly needed to improve targeting through effective use of resources. The joint headquarters should coordinate the C^3I node targeting effort to prevent duplication of effort and ensure the development of a coordinated targeting strategy. Target management is essential in light of dwindling resources. This should be initiated prior to commencement of hostilities to ensure that sufficient time is available to develop and obtain targetable locations on all critical nodes. This board should be functional during the

peacetime planning process.

Two areas where Army achieved success were its deep fires against fixed Scud sites and the introduction of the ATACMS system. Knowledge and prewar surveys of Iraqi Scud tactics and intelligence data could help focus on location and targeting objectives of Scud firing sites. However, during the war it soon became apparent that the Iraqis were operating from a number of defined "launch baskets." As the war progressed, the number of launch baskets decreased. By war's end, the Iraqis were launching almost exclusively from the Wadi Al Jabariyah area in the west, the Safwan area in the south, and the Baghdad area in central Iraq; the latter probably as a result of the Coalition threat in the southern launch baskets.[57] Despite this intelligence and the dedication of a large percentage of the Coalition's air assets to the counter Scud missions, the operation continued to be difficult. The Army, however, was able to deploy a new weapon system that proved to be very effective during both air and ground operations.

The Army's ATACMS weapon system played a significant role in the accomplishment of the attack operations mission. One ATACMS field artillery battalion was deployed to Saudi Arabia in August 1990. A majority of the battalion had deep attack capable launchers in support of the operation. As with Patriot missiles, missile production was accelerated and

available missiles were delivered to the theater. The ATACMS missile is a semi-ballistic, inertially guided, surface-to-surface missile launched from a launcher. The warhead contains bomblets effective against soft and semi-hard stationary targets. Several missiles were fired during the war, during both air and ground operations. Although battlefield damage assessment (BDA) was limited, information indicated system performance exceeded all expectations. The surface-to-air missile (SAM) suppression mission removed potential threats to friendly aircraft and freed air assets for other targets. The firepower it generated was devastating and overall the system proved lethal, reliable, and accurate.

Although relatively successful, joint and Army doctrine is not yet adequate. Appropriate target sets and engagement criteria, targeting parameters, and the requirement for a joint definition of the fire support coordination line must be addressed. Future tactics, techniques, and procedures manuals should address situational employment considerations. Efforts must be made to develop both air and ground operations for integration with a mature joint command and control system to interface with the ATACMS. Although the joint surveillance target attack radar system (Joint STARS) was available to provide targeting information, a direct link to the ATACMS firing batteries to

allow rapid communication of this information must be maintained. Before the introduction of ATACMS, coordination of airspace for artillery fires was relatively informal. Because MLRS has a maximum ordinate of approximately 30,000 feet, and ATACMS a maximum ordinate of approximately 100,000 feet, more detailed management of airspace is critical.[58] Given the maximum ordinate of the missile, the old theory of "big sky - little bullet" was no longer valid. Defining an airspace coordination area and disseminating it to all airspace competitors is time-consuming and results in unresponsive fires.

Army airspace command and control (A2C2) cells must be active in acquiring airspace for rocket and missile firings. Battlefield coordination element (BCE) personnel, collocated with Air Force personnel, can provide necessary liaison for clearance of planned ATACMS firing. The airborne warning and control system and the airborne battlefield command and control center (ABCCC) airborne platforms have the capability to plot the launcher location, target location, and quickly clear the associated airspace for missile launches. Doctrine, tactics, techniques and procedures are currently lacking and must be formalized to provide specific guidance for necessary airspace coordination.

Army special operating forces (SOF) and SOF aviation successfully attacked key enemy C^3I systems; conducted

reconnaissance behind enemy lines; and helped destroy mobile Scud missile launchers. Limited targeting information was also obtained through Army reconnaissance teams; however, Army SOF lacked adequate day and night optics for these special reconnaissance teams. During operations Army special forces were tasked to conduct static and mobile border surveillance and special reconnaissance missions behind enemy lines. The missions varied from reporting enemy activities across the border to locating critical targets, routes, key terrain, and units deep behind enemy lines. These missions were conducted with organic observation devices which were much less than adequate for the missions assigned. The lack of range, clarity, and performance during periods of limited visibility forced the teams to locate hide positions much closer to the target area, reducing the amount of terrain the teams could observe and increasing the chance of compromise. The full results of SOF in the reconnaissance and target spotting role against Iraqi Scud operations are unclear largely because of the security concerns surrounding SOF operations; however, the need for better optical devices is apparent.

The same targeting difficulties discussed also contributed to the problems in measuring the effectiveness of bomb damage. Traditional measures of effectiveness based on thorough battle damage may not always be possible.

Estimating attrition of Iraqi forces in general was difficult. It was nearly impossible to confirm destruction of dug in or hidden targets such as Scud transporter-erector launchers (TEL). There were significant differences in the level of attrition that the national intelligence community was able to confirm as opposed to the damage estimates developed in theater. Doctrinally, procedures for the development of BDA should be standardized. It would be helpful if one organization or element was responsible for the development and dissemination of BDA. Training and a review to determine new system requirements for the Army should be examined. Experience during Operation Desert Storm showed that reconnaissance systems and BDA techniques were easier for stationary targets (buildings, bridges, etc.) than for mobile targets across a vast battlefield. Personnel making assessments lacked training in US weapon system capabilities and discounted the effects of many of our weapon systems. Experience after the fact showed that more damage had been done by these air delivered systems' munitions than had been assessed. While this did not adversely impact the outcome of Operation Desert Storm, in other campaign scenarios key opportunities might be missed or poor decisions made without an adequate assessment of the enemy's battlefield capabilities.

The difficulties faced by the Coalition in regards to

targeting and BDA did not result in total failure. Comparison of Iraqi mobile Scud operations of the Iran-Iraq 1988 "War of the Cities" and the Gulf War indicates that Coalition anti-Scud efforts had a significant effect on reducing Iraq's operating tempo.[59] Although other factors may have affected the numbers such as war aims, strategic goals, and policies, there are apparent differences surrounding Iraqi strategy during the two conflicts. Over the eight week period of the War of the Cities, Iraq averaged 22.3 launches per week. During Operation Desert Storm, Iraq average only 14.7 launches per week, a thirty-four percent decline.[60] The relatively low operating tempo that Iraq exhibited during Operation Desert Storm is particularly striking since the Iraqi launcher inventory may have increased by as much as thirty percent between the Iran-Iraq war and Operation Desert Storm.[61] The low operating tempo that Iraq sustained during Operation Desert Storm is especially evident in specific launch belts over different periods of time during the war.

This analysis of the first two JTMD mission areas begins to indicate Army capability in the JTMD mission. Without adequate capability in the DTLOM areas the missions of JTMD can not adequately be performed, while good capability in these areas will significantly contribute to the ability to execute the mission. The Army has

demonstrated a significant capability in some areas and weaknesses in others as summarized in the ratings provided in the beginning of each section. Improvements in the DTLOM areas mentioned will help to improve overall JTMD capability as seen by an analysis of the final two JTMD mission areas.

Passive Defense

The majority of the information available for passive defense measures analysis falls in four principal areas: early warning, NBC operations, deception, and effective space support. Measures such as cover and concealment, communications discipline, and dispersion used to support tactical and operational goals, were also considered in the ratings summarized below.

	DOCT	TNG	LDSHP	ORGAN	MATERIAL
PASSIVE DEFENSE	C1	C2	C1	C2	C2

It is difficult to gauge just how much passive measures contributed to countering the Iraqi Scud threat during the Gulf War. As a minimum, the Scud missile threat

required increased troops and materiel dispersal and caused measures to be taken to provide early warning of missile launches and predicted impact zones. The Scud threat also dictated heightened states of alert and readiness for self-defense against chemical and biological warheads.

Part of the passive defense mission required measures to assist in predicting, detecting, and providing timely warning. It is normally difficult to forecast a Scud launch; however, the defense support program (DSP) employed assets to detect and verify Scud launch location, determine a predicted impact area, and provide warning to the theater CINCs through reporting systems. The DSP consisted of sensor satellites capable of detecting detailed infrared events such as a ballistic missile launch. During exercise Quiet Sunset 1989, and Torpid Shadow 1990, the operational DSP tactical event reporting system was tested and proved successful.[62] These two special projects constituted the basis for theater missile defense warning during Desert Storm. Although US Space Command, US Central Command, and Strategic Air Command personnel did a lot of work setting up this system, much of the doctrine and many materiel systems were not in place and formalized. Therefore, the system was not clearly understood by all users. The capabilities of space assets must be ingrained in joint planning and practiced in exercises at the national, theater, and unit levels. The Army must ensure

that is has the proper doctrine and materiel means to participate and make the most effective use of space based systems. Overall, once the system was established the DSP warning system gave an excellent account of itself during Operation Desert Storm. A look at space-based warning and Patriot anti-TBM fires identifies the Army's best capabilities in this area given the limitations mentioned.

The combination of space based warning and Patriot anti-TBM fires was one of the great success stories of the war. The reliable TBM warning became a trademark of US efforts in the Gulf War and was the result of an unprecedented application and integration of technical resources, communications, and the experience of missile warning crews. The Army should continue to pursue doctrine and material means and take actions to ensure that future operations are supported by a reliable and effective missile warning systems on short notice. The overlap of strategic and tactical warning is being studied and doctrine for the use of ground-based systems in combination with space is in progress. Additionally, materiel improvements must continue to be pursued and doctrine for centralized missile warning supported by responsive communications is needed.

The Gulf War demonstrated the need for a standard tactical early warning architecture. There were several different systems used, all designed to accomplish the same

thing. Units deployed to Saudi Arabia with various configurations of early warning systems and, for the most part, could not interface with each other. Some of the systems used included the forward area alerting radars (FAAR), ground-based observers, liaison teams with Patriot units, and the tactical Army data-link system distribution system (TADS).[63] Further complicating the establishment of a standard early warning system during Operations Desert Shield/Storm was the absence of an ADA brigade headquarters to support each corps. The TADS was purchased to help fill the need to receive joint early warning. The TADS is a small, portable data link processing and forwarding system used by the AF.[64] During Operation Desert Storm ADA units could use TADS to receive information from the Air Force, Navy, Marine Corps, and allies. This technique was finally developed and eventually used to receive airborne warning and control system (AWACS) data (TADIL-A) and pass it to Patriot battalions very effectively.

Additionally, maneuver forces do not have an organic sensor to provide air threat early warning. Throughout Desert Storm, tactical units did not always receive accurate or timely tactical missile warning alerts. Failure to provide early warning of TBM launches can impact seriously on force protection, morale, and strategic resolve. As Operation Desert Shield began, the withdrawal of the forward

area alerting radars (FAAR) from some divisional air defense artillery battalions was underway which removed the organic early warning sensor these divisions. Units became dependent on Patriot units in the division area to provide long-range, early warning via liaison teams. In those cases where a Patriot unit was not located in the area of tactical units, there was no long range early warning coverage over the maneuver force. Liaison teams collocated with Patriot units were limited by communications capabilities and transmission ranges. The fielding of the forward area air defense ground based sensor scheduled later in this decade should satisfy the existing air defense requirement. However, the larger issue of warning to deployed forces remains unresolved.

The threat of chemical or biological attack forced coalition units to train and operate frequently in protective gear called mission oriented protective posture, (MOPP). Although no such attacks occurred, Desert Storm experience was useful in assessing the suitability of protective gear and other defensive measures for desert use. As the crisis progressed, intelligence assessments focussed on the possibility that, among many agents, Iraq had developed the use of both anthrax and botulinum toxins. At the outset of the conflict there were no systems available to detect attacks, so there were no mechanisms to provide warnings. Vaccines were not available in significant quantities until

early 1991.[65] In August 1990, the Department of Defense did not have a policy regarding vaccination against BW agents. With the Army serving as executive agent, DOD promulgated a vaccination policy.[66] The Army and Navy established laboratories in the theater with special upgrades to identify and rapidly confirm any BW use.[67] To make use of data, the command and control system prepared to pass time sensitive information and warnings back to the NCA and down to the lowest troop echelons.

Of particular interest in the NBC area was the performance of the Fuchs NBC reconnaissance system. Chemical reconnaissance units operated these systems with just three weeks of training, and they were able to conduct missions rapidly over wide expanses of terrain and provide real-time information on suspected chemical attacks. All items of chemical defense equipment were used extensively both in training exercises during the buildup phase and during the offensive portion of the campaign. Initial reports suggest that this equipment performed as it was designed, despite the harsh desert environment. Large quantities of expendable supplies were consumed in training as units developed their chemical defense skills in preparation for expected Iraqi chemical attacks. Many units donned chemical protective ensembles at the start of Operation Desert Storm and continued to wear portions of them throughout the ground

offensive phase. Extensive training acclimated soldiers so the additional heat of this equipment during Operation Desert Storm would not unduly slow the pace of offensive operations. However, similar activities during summer months would have been much more difficult.

Protection against biological attack does, however, need improvement. Some of the procedural systems were slow and inadequate. NBC systems that assist commanders to avoid biological contamination or to determine when it is safe to have soldiers unmask need reevaluation and training emphasis. Medical treatment and evacuation systems were also developed to improve Army's ability to accomplish protection. A future TMD system may provide such an effective defense that it may produce hazardous effects to unsuspecting friends if it destroyed an enemy missile armed with chemical or biological agents. However, until that capability is achieved, tactics, techniques, and procedures to support avoidance, protection, decontamination, and treatment must continue to be trained and practiced. The development of biological point detectors should also continue.

Additionally, doctrine for NBC protective equipment should be examined in more detail. After the first Scud missile attacks on Saudi Arabia, units quickly used their chemical protection equipment. Plans should carefully

consider the amount of protective garments and equipment that may be needed over time. The established criteria for the wear-life of protective overgarments and for replacement of protective mask filters came under intense scrutiny due to limited supply and its impact on operational requirements. Last minute changes to doctrine were made after forces were deployed. These changes served to instill a loss of confidence in the doctrine and equipment soldiers had been assured would protect them. Actions by the Army, as the DOD executive agent for NBC matters, is needed.

Army and Air Force NBC alert and warning systems are incompatible.[68] The sirens, mission oriented protection posture (MOPP) levels, and MOPP level designation varied between the two services. This caused confusion among Army and Air Force personnel when both were stationed on the same base. Army units also reported difficulties exchanging NBC warning and reporting information among bases and base clusters in rear areas. Doctrine and training systems for this specific passive defense capability were not adequate. Joint procedures for an NBC alert and warning system are needed. This action should be coordinated with all services. Material and organizational fixes are needed to ensure that rear area units are equipped with the proper communications to provide alert and warning information.

Finally, as a major success in passive defense

capability, Army deception operations were an integral part of the overall strategy for Desert Storm. Planning began in early August and remained an essential element of the campaign. The goal of these operations was to keep the enemy off balance and disoriented as to the actual strength, location, and intentions of Coalition forces. A deception story was designed to convince the Iraqis that Coalition forces would directly attack Iraqi positions in Kuwait, supported by an amphibious assault on the Kuwaiti coastline, when in fact the main ground effort would be penetration in the west into Iraq itself. This deception played on pre-existing Iraqi expectations.[69] USCENTCOM implemented a plan that reinforced those expectations. Prior to Operation Desert Storm, the deception plan included amphibious rehearsals and exercises, training airspace locations, air refueling and early warning orbits, air combat exercises, trench warfare training, and minefield breaching operations. After hostilities began; but prior to the ground campaign, operations included border probes, artillery raids, feints, and air strike packages.

The Coalition's ability to deny airspace to Iraqi reconnaissance aircraft and Iraq's lack of space surveillance assets helped ensure that the main effort in the west remained undetected to Iraq. Inasmuch as Iraq had virtually no ability to conduct surveillance or collect information on

Coalition dispositions, it is difficult to evaluate the impact of deception operations on Iraqi Scud operations. Deception and other passive defense measures would be more significant when confronted by an enemy with both a space surveillance and a TM capability.

Command, Control, Communications and Intelligence (C^3I)

	DOCT	TNG	LDSHP	ORGAN	MATERIAL
PASSIVE DEFENSE	C4	C3	C3	C2	C2

In August 1990 there was little in the way of a communications infrastructure in Southwest Asia. Unlike the well developed infrastructure of ports and airfields, communications systems were rudimentary. The command, control, communications, and intelligence system built to support the Coalition was not a simple task.

The Coalition was large and diverse, more than 800,000 personnel from thirty-six nations with dozens of different weapons systems.[70] In addition to equipment differences among various members of the Coalition, there were

differences among US forces. Ultimately, several generations of equipment and many different commands and staff elements were melded. The resulting systems accommodated an unprecedented demand for communications of all types. US, Coalition, and commercial communications assets were employed to support deployment, sustainment, and combat operations. All this required considerable innovation. The success of Coalition forces during Operations Desert Shield and Desert Storm was due in no small measure to the overall effectiveness of the command, control, and communications systems. The following discussion will serve to analyze the last JTMD mission according to DTLOM criteria.

While it is important to examine and assess the equipment used to construct the C^3I architecture, it is equally important to assess the command and control arrangements that were established to effectively control and direct the forces in theater. Although much of the following discussion centers on the capability of the theater, it is necessary to understand to relate Army effectiveness as it pertains to Army portion of the C3I operations. Much of the success realized is a result of the Army's organizations, leadership, and material system capabilities.

Operation Desert Storm owes much of its success to a C^3I system that for the most part got the job done. The Coalition Coordination Communications and Integration Center

(C^3IC) and the combined planning teams were formed to accomplish this command and control function.[71] Due to a myriad of political, military, and cultural considerations among countries participating in the Coalition, separate parallel lines of command/authority were established. In general, Islamic forces were organized into a Joint Forces/Theater of Operations command structure under Saudi Lieutenant General Khalid bin Sultan bin Abdul-Aziz. The Commander-in-Chief, Central Command (CINCENT) commanded US and other non-Islamic members of the Coalition. However, no single overall commander was designated. The C^3IC was employed to ensure that the lack of a single "supreme" commander did not disrupt operations. C^3IC was the conduit for General Schwarzkopf and Saudi Lieutenant General Khalid to coordinate and plan the efforts of Coalition forces. The C^3IC coordinated efforts of American, British, and French forces with those of the Arab/Islamic forces. The C^3IC concept had been discussed with the Saudis prior to the crisis, but had never been tested or exercised in peacetime. These practices and command relationships are now being put into doctrine. Many organizational, material, and leadership areas are being updated to reflect the general successes and training conducted to maintain this same level of proficiency.

Once established, the systems and procedures for

command, control, and communications of US Army forces worked; however, not without significant changes and problems in effectiveness experienced on a daily basis until hostilities ended.[72] A number of factors helped improve command and control systems despite integration challenges. In some instances, C3IC was enhanced through the use of secure telephone units (STUs), personal computers, fax machines, the sharing of national and commercial satellite resources, and the exchange of liaison teams to overcome language and technological problems. Doctrinal exceptions were required to allow the use of some items of equipment by foreign Coalition members. The variety of equipment in use required the communications architecture to be improvised as requirements for systems became known. For example, there was a requirement for an interoperable, secure voice system. An architecture that satisfied this requirement was constructed. However, while it was possible to build the structure around existing equipment, various innovative modifications and upgrades were required. A look at Army communication equipment, and particular ADA assets, further helps to analyze C3I capability for the JTMD mission.

An Army AD brigade's communications assets were insufficient to support their role as the theater army air defense command headquarters. As the integrated air defense structure was refined to include all joint and Coalition

forces, ADA brigade headquarters communications requirements outstripped its capabilities.[73] The ADA brigade supported operations throughout the theater of operations; the connectivity stretched from Tobuk to King Khalid Military City, to Ad Dammam, to Riyadh. Organic communications equipment had to be augmented to meet requirements. The brigade also filled twenty unprogrammed liaison personnel positions at seven locations to enhance coordination and command and control. Each liaison mission was accompanied with an associated communications requirement. Neither ARCENT nor USCENTCOM could adequately plan joint communications in support of air defense operations.[74] The planning and coordination between the 11th Air Defense Brigade and the Air Force was accomplished by direct on the ground coordination or through the 11th Signal Brigade when its assets were involved. The contributions of liaison officers in solving communications requirements were significant.

Patriot air defense communications equipment for both digital and voice communications are limited. Patriot does not have the tactical digital information (TADIL-A and TADIL-B) capabilities of other services. Again, systems had to be designed on the spot to integrate Army air defense units into the joint tactical air operations (JTAO) system. A great deal of effort and resources were expended to

integrate Army air defense units into an integrated air defense system (IADS). This effort could be reduced or eliminated if systems used by Army air defense units were compatible and interoperable with all other agencies. Limitations degraded the effectiveness of joint interoperability for all joint tactical air operation missions. As an interim measure, air defense communications should be upgraded to include TADIL-A and TADIL-B capabilities with other services; additional upgrade to TADIL-J should be pursued to provide the same capability as other improved contemporary systems. TOE communications assets should be increased to maintain additional voice circuits with other services. Air defense units were also limited in the number and type of voice communications (VHF, HF, UHF) systems available to them. Equipment assigned to Patriot units was limited in number and lacked sufficient range, capability, and secure gear.

The specific combination of communication systems, detailed below, displays the diverse communications requirements needed by the Patriot system. The command and control of Patriot fire units is performed by the ICC (AN/MSQ-116), the nerve center for Patriot air defense operations.[75] The ICC provides automatic data processing (ADP) and communications capabilities required to operate with other air defense systems. The ICC communicates with

the fire direction center (FDC) using the Army tactical data link. Through the FDC the Patriot system is interconnected with other weapons and surveillance systems. For example, the FDC uses the automated command and control system (AN/TSQ-73) to communicate with the Air Force tactical air control/tactical air defense system (TACS/TADS) and the Air Force air defense command and air warning control systems. The AN/TSQ-73 equipment also provides a link with Army and Marine Hawk air defense units. The key to battalion operations is the ultra high frequency (UHF) communications link that ties the information and control center (ICC) to the brigade C^2 element and to the engagement control stations (ECS). Data communications over the UHF link are handled by the ICC and the ECS computers to provide information from and to the firing battery. The ECSs, through their weapon control computers, control associated launch stations via a fiber optic very high frequency (VHF) data-link. Tactical radios are also used between the ICC and the ECSs and between the ICC and the AN/TSQ-73. Additionally, a radio teletypewriter organic to the battalion links the battalion to the brigade. Other radio communications nets and wire circuits are available throughout the battalion for command, administration, and logistics.

As described above the various communication systems

required to command and control the Patriot system is very diverse and complex. Shortfalls in equipment significantly decrease the effectiveness of the entire C^3I mission. With the addition of the TBM role, Patriot has emerged as a system with a variety of roles. Future Patriot communications systems must be compatible with Air Force C^2 sources. Operating under a centralized airspace system, coupled with the high likelihood that Patriot firing batteries will have to stand alone for some periods of time, it is essential that they be able to establish data links with higher C^2 sources. Patriot communications systems need to be more flexible, have longer range capability, and be able to sustain more links.

Another interoperability problem affecting Army operations was the need for effective Joint Communications Electronic Operating Instructions (JCEOI). During the initial stages of the operation it also became apparent that a JCEOI was essential to effectively manage USCENTCOM C^3 assets. The JCEOI would provide information required to make the C^3 system work efficiently. Eventually, the JCEOI provided information required to operate more than 10,000 different radio nets. Organization and materiel improvements are needed to help integrate and modernize joint air defense operations. The solutions used in the Gulf war were for the most part ad hoc; requirements should be laid out for future

modernization.

Satellite communications played a significant role in the Gulf operations. Military satellite communications and other systems all helped keep Army C^2 elements informed of significant activity in the theater. Overall, there were several different military and commercial satellite communications supporting USCENTCOM operations. Operation Desert Shield and Desert Storm highlighted the increasing dependance on Military Satellite Communications System (MILSATCOM). The largest ground mobile forces (GMF) network ever established was created to support Desert Shield and Desert Storm.[76] Organizational and doctrinal changes are needed to include increased requirements for GMF support. There is no capability to quickly provide additional space segments to support an increase in GMF requirements, nor is there a capability to provide back up for existing GMF capacity in case of a catastrophic failure. Loss of either of the two Indian Ocean DSCS satellites supporting Desert Storm, from component failure or enemy action, would have had a severe impact on combat operations. Materiel and doctrine improvements could be made to reduce the chance of failure. The services should review their doctrine concerning the use of GMF SATCOM in light of Desert Storm to establish a requirements baseline.

The exploitation of Tactical Satellite Communications

systems was relatively successful; these systems provided enhanced signal support to the AOR and gave a highly mobile, extended range capability to the maneuver commander on a fast paced battlefield.[77] However, the UHF and SHF satellite systems in use were vulnerable to jamming. If the Iraqis had employed jamming, it would have had a negative impact on primary strategic lines of communication and on the command and control infrastructure within the theater. The Army has begun work on a solution based on a satellite system operating in the EHF range. This effort is currently in the operational requirements document (ORD) stage of development.[78] While EHF has certain inherent jam resistant characteristics, technology is available to include anti-jam capability into a satellite system in other ways. This technology can also be used to increase the jam resistance of systems in the SHF and UHF ranges.

An Army success was the development and use of the global positioning system (GPS). Personnel and navigationally guided weapon systems benefited from its accuracy as well. The Standoff Land Attack Missile (SLAM) used GPS for mid-course guidance allowing pilots greater stand off distance, while other aircraft used GPS for improved navigation accuracy, to enhance emitter source location, and to precisely locate downed aircrews. GPS gave the forces a major advantage over the Iraqis. It was

critical to the ability of ground forces to conduct maneuver, fire support, and logistical resupply operations over the vast featureless desert terrain. GPS also allowed precise mapping and marking of minefields.

In addition to technological assets of satellite systems, liaison teams from USSPACECOM were developed to visit service headquarters for information briefings concerning space support. This proved highly effective.[79] Doctrine and organization changes should incorporate the liaison team concept to improve overall capability. An operational concept for regular use of a liaison team to support CINCs and services could enhance space support available from USSPACECOM.

Another highly effective C^3I system was the Joint Surveillance and Target Attack Radar System, Joint STARS, and the Army's deployment and use of the ground station modules, GSM. The system is designed to detect, locate, and track moving and stationary equipment ground targets located beyond the forward line of own troops. The GSM disseminates intelligence and target data to Army C^3I nodes via wire or radio, enabling integrated battle management. Although this system provides a significant capability in the attack operations role through targeting information, its role as a vital C^2 node contributed to improved capabilities in the C^3I mission as a whole.

Joint STARS consists of an airborne platform as the major component and the ground station module (AN/TSQ-132), which is a mobile intelligence, data processing, and evaluation center. Two Joint STARS platforms and crews were available during the war which could only operate eleven hours a day.[80] Several doctrinal considerations have been realized and are worth developing. Unified command and control of Joint STARS tasking was effective in ensuring equitable distribution of this unique platform and application in accordance with theater targeting priorities. Army use of the Joint STARS GSM was of significant value during Operation Desert Storm. Ground commanders received Joint STARS information via a downlink to the GSM. Since the prototype Joint STARS used in Operation Desert Storm had a limited number of GSMs, only ARCENT and the two corps received Joint STARS information in near real-time. The Joint STARS GSM should be fielded in adequate numbers to provide a more robust capability in a theater of operations than was achieved in the Gulf War. These assets provided an improved C^3I capability throughout the war. Its capability should continue to be pursued and systems established to support its development.

Command and control elements must be given greater importance for deployment. The requirement to push armor-heavy forces forward dictated that many air defense

fire units be deployed without command, control, and support elements. By the final phase of the deployment, all AD assets were commanded by one air defense brigade, which was forced to address the concerns of two corps and all echelon above corps commanders. This brigade served as the theater air defense headquarters and was responsible to ARCENT for all air defense matters including interface with the Air Force. The two corps that deployed in support of Operation Desert Storm deployed without dedicated air defense brigades. This created many problems inasmuch as divisional air defense battalions were unable to tie into the proper communications channels to receive a complete air picture.[81] Whenever possible, air defense forces should deploy with all required command and control and maintenance support elements to improve doctrine and organizational systems needed for effective mission accomplishment.

The problems experienced by not having a brigade C^2 element for each forward deployed corps validated Army AD doctrine for this required organization. During the Gulf War one ADA brigade provided support to the two deployed corps. Hawk/Patriot battalion task forces deployed attached to each corps. The 11th Air Defense Artillery Brigade Headquarters was tasked to provide air defense command and control for two corps to plan, coordinate, and execute critical theater asset defense (ports, airfields, logistical bases, and theater

headquarters); formulate Army air defense policy; interface with the Theater Air Defense Command structure; and perform planning, liaison, and logistical functions at theater and corps levels. This brigade at reduced size would normally support one corps versus two. It experienced some equipment problems needed to perform these operations and required extensive personnel and equipment augmentation to perform essential command, control, planning, logistics, and liaison missions. At times the 11th ADA Brigade had units dispersed over hundreds of square kilometers; several units were involved in both operational and tactical fights. This placed undue strain on the brigade headquarter's ability to control, communicate and sustain the force. In future contingency operations of this size, deployment of a theater Army air defense command (TAADCOM) is essential to provide ADA interface at the joint level.

Airspace command and control procedures need improvement. The Air Defense and Airspace Control Procedures for Operation Desert Storm was developed by the AF commander who performed the duties of Joint Force Air Component Commander (JFACC) and Area Air Defense Commander (AADC).[82] His responsibility included the establishment of the airspace control order (ACO). This document set forth the roles, responsibilities, and procedures for airspace management, tactical command and control operations, air-to-ground

operational procedures, and air defense operations. Surface-to-air missile and air defense artillery operations are also addressed in this document. Although the document addresses all aspects of air defense and airspace control in great detail, no provisions are made for the unique requirements pertaining to theater missile defense. It is suggested that future publications of this sort address specifically the roles and responsibilities for theater missile defense.

Furthermore, Army airspace command and control, A2C2, equipment and procedures are not sufficiently flexible to meet the airspace user requirements necessary for effective TMD mission accomplishment Effective airspace management is dependent on timely dissemination of an accurate air tasking order (ATO) and on real-time communications with all airspace users. Communications problems, untimely ATOs, and inaccurate inputs to the ATO all contributed to the problems of airspace management during Operation Desert Storm. Airspace users were required to provide their missions and airspace needs to air planners for inclusion in the ATO. Units failed to provide accurate and timely inputs to the ATO. This failure was due to inadequate communications links and the dynamic nature of airspace management.[83] Dissemination of the ATO, vital to all air users, was hindered by insufficient numbers of CAFMS terminals and

connectivity to key elements. Flight following procedures were hampered during tactical operations due to the requirement to use FM secure radio. FM radio is line-of-sight and does not have the range capability the air traffic service (ATS) facility requires.

The amount of detail needed to plan operations for more than 1,000 sorties per day includes inflight refueling call signs, frequencies, times, locations, altitudes, target munitions, and more.[84] Equal or greater detail needs to be assembled for electronic countermeasure support, escort, or combat air patrol, AWACS or ground controllers, forward air controllers, and search and rescue. The result is an air tasking order (ATO) the size of a New York City phone book that is time consuming to prepare, disseminate, and digest. Automated systems must continue to be pursued to help manage this process. The typical time to transmit a record copy of the ATO was two hours. The Air Force Computer Aided Force Management System (CAFMS) used to produce daily ATO was not fully interoperable among the services.[85] The lack of a sufficient common transmission media to send and receive the ATO between the Air Force and the Navy was a problem. Although additional solutions were being investigated prior to and after the outbreak of war, the primary means of distribution was often to ferry the ATO, on floppy diskette, each night from Riyadh to service headquarters.[86] Efforts

should continue to streamline the ATO process, reduce transmission time, and procure compatible equipment in order to ensure full interoperability.

Airspace control measures were frequently disregarded by aircrews. Air superiority, positive control of air defense artillery fires, and non-doctrinal weapons' control status led to a false sense of invulnerability. Often, friendly aircraft avoided engagement only through involvement of ground-based air defense tactical directors. Inaccurate and outdated flight information publications (FLIPS) caused problems in aviation operations. Frequently, information published for air traffic service facilities was not timely or correct. Doctrine and material systems need improvement. The A2C2 system should be reevaluated with a view to establishing improved procedures to facilitate airspace control measures, surveillance areas, and command and control relationships. The air traffic service facility should be upgraded with long range communication facilities and equipment capable of interfacing with CAFMS.

The final area in the C^3I assessment is the Army intelligence effort. All operations require an effective working relationship between the C^3 and the intelligence communities. As seen, elements of the communications network were incompatible and subject to failure; therefore, the intelligence effort was also degraded. Additionally, a joint

intelligence collection effort was slow. A general lack of collection and dissemination guidance for the intelligence effort caused duplication of effort and lack of dissemination to critical C2 nodes. In order to minimize disruption and expeditiously correct problems of this nature, a joint consensus on issues and policy directions is needed. An MI board is needed to resolve C^3I issues and improve coordination between the JFC and the services to improve communications and intelligence interface.

Despite communication problems the Army intelligence community began a worldwide search for information that might be of value to US decision makers and military commanders. Areas of interest were military and government facilities constructed by foreign firms; Iraqi nuclear, chemical, and biological weapons research programs; capabilities and characteristics of Baghdad's modified Scud missiles; and foreign weaponry in Saddam's arsenal.[87] Assistance from the nations united against Iraq was helpful. Although field expedient solutions were developed, it was often at the expense of timeliness. Eventual use of national and coalition assets greatly assisted the intelligence effort.

The Army OV-1D Mohawk proved to be a valuable asset. Theater intelligence collection and dissemination systems remain critical to providing a clear picture of the battlefield. Preplanning for assets and requirements is an

ongoing process and must continue to be prioritized and stressed to insure immediate availability of equipment at the outbreak of hostilities. Since most theater collection systems were newly developed, details on how to use them in conjunction with each other or in conjunction with national collection systems were being developed. As a result, the systems were effective but not yet optimized to their full potential.[88] Make shift means only caused confusion and hindered the overall effectiveness of the theater intelligence effort. Doctrinal procedures must continue to be formalized.

Intelligence communication needs to remain a high priority, especially during periods of intense activity. A problem in disseminating intelligence message traffic to the proper activities was slow to be resolved. The ARCENT Intelligence Center required immediate and unimpeded communications with all levels of intelligence collection sources to exchange, disseminate, and exploit rapidly time sensitive information. Often the lack of available communications connectivity and priority of lines made this very difficult. Delays in receipt of information could render information useless. Army C2 nodes may require dedicated communications with certain agencies and organizations to expedite critical intelligence. Requirements for dedicated circuits should be evaluated and

then, as appropriate, incorporated into future operations plans and other planning documents. Personnel should be trained to fulfill these requirements and the plans should be incorporated in training exercises.

The number one intelligence problem throughout Operations Desert Shield and Desert Storm was the inability to get timely imagery to meet demands for mission planning, order of battle, and bomb damage assessment.[89] The Iraqi surface-to-air missile operators rarely used their radars long enough for their positions to be fixed, so the only way to locate them was through imagery. The entire air operation strategy was impacted by the inability to get timely BDA which was based exclusively on imagery. Doctrine and materiel emphasis needs to be placed on the data-link systems such as SYERS, ASARS, and Joint STARS.

Tactical reconnaissance provided the best quality imagery and a tactical reconnaissance data link should be considered.[90] Additionally, a reliable, deployable, and secure imagery transmission system that is compatible with existing equipment of all services is needed. Wide area systems should continue to be developed. US Army ground force target planners need this imagery for timely target planning and mission execution. A Joint Imagery Production Complex JIPC-like capability should be created, exercised, trained, and made available to theater commanders when

required in support of contingency operations. Overall, intelligence support to Operations Desert Shield and Desert Storm was a success. This success reflected investments in technology and the efforts of thousands of individuals. Nonetheless, there were problems, compounded by the magnitude of the intelligence effort and the number of systems and agencies involved. These problems were especially acute when it came to locating Scud missiles, Scud TEL, and launch operations.

CHAPTER FIVE

SUMMARY/JUDGMENTS

The evidence and analysis provided from recent experiences and operations, primarily Desert Shield/Storm, produced information which helped identify Army capability in a JTMD mission. The preceding chapters established Army requirements and cited specific examples in each of the four functional areas of TMD needed to help further develop or maintain Army JTMD capability. The remainder of this thesis summarizes Army JTMD capability, and provides judgments and areas for future study.

Judgements

	DOCT	TNG	LDSHP	ORGAN	MATERIAL
ACTIVE DEFENSE	C3	C3	C3	C2	C2
ATTACK OPERATIONS	C3	C2	C3	C2	C2
PASSIVE DEFENSE	C1	C2	C1	C1	C1
C3I	C4	C3	C3	C2	C2

Ratings above highlight evidence and summarize the analysis made in chapter four. The compilation of observations presented in this thesis shows that the Army is inherently involved in several aspects of the JTMD mission. Analysis of the ratings depicted in the matrix helps to draw judgements concerning both JTMD missions and associated DTLOM criteria, keeping in mind that evidence was sought to prove capability in a certain area. Eight judgements, in respect to the analysis provided, should be considered to improve or maintain Army TMD capability. Further comments about specific JTMD mission areas are addressed in this section.

a. **Joint and Army TMD doctrine must be developed and formalized.** We need to formalize techniques and procedures to effectively use what we have. Responsibilities must be clearly understood and practiced by all. Time will not be available to rely on ad hoc systems.

b. **JTMD Mission areas must be better trained.** Once doctrine is set organizations should practice to improve and maintain proficiency needed to accomplish the mission.

c. **C^3I mission area needs most improvement.** Steps to improve communication systems will help to improve Army TMD capability and resolve other C^3I related weaknesses. Inter and intraservice communications must be improved.

d. **Overall, material systems are adequate for JTMD missions, in light of the current threat.** Most benefit from material improvements could be realized by incorporating improved technology for defense against missiles in flight. Technology is available to improve capability in the Army's active defense mission and C^3I.

e. **Current passive defense measures are adequate.** Passive defense mission is practiced as part of other missions and is often adequate once evaluated as part of the JTMD mission.

f. **Minor adjustments are needed to Army organizations responsible for TMD mission.** In place organizations can be used to accomplish missions once the doctrine is commonly understood and trained.

g. **Army attack operations capabilities should be further developed as a primary means to accomplish JTMD.** The Army has significant capability in attack operations it has not yet fully used.

h. **Centralized targeting management is needed.** Must explore ways to shorten current target intelligence, mission planning, and force execution timelines to exercise an adaptive targeting architecture.

Active Defense

The Gulf War demonstrated the unreliability of

deterrence against countries and leaders who are likely to be misunderstood by Western leaders. Saddam Hussein defied the "logic of deterrence" by launching Scud attacks against Israeli cities, despite the near certainty that Israel is nuclear-armed and renowned for its propensity to retaliate.[91] The US nuclear deterrent may be near irrelevant, in many such cases, given the likely disbelief by foreign leaders that the US would use nuclear weapons under such circumstances. Despite the abundance of assertions about deterrence, when and how it will or will not work is unpredictable. The Gulf War provided an example of how the Patriot system helped prevent escalation by providing a non-provocative alternative to offensive retaliation.[92] As was shown, defenses will be an important complement to the traditional reliance on deterrence if the US and its allies are to have reliable protection against Third World missiles.

Taken in total, the facts and analysis presented in chapter four show that Patriot is a capable weapon system. The Army is very capable of performing the active defense mission with this system. However, critics have come forward since the Gulf War stating that Patriot didn't perform as well as claimed.[93] Criticism of the Patriot system seems to be based more on opinion and judgement than on facts. One analysis used Cable News Network (CNN) film footage to conclude that Scud warhead kills were never

achieved. This analysis made no reference to mission kill and thereby discounted the Patriot as a means of thwarting incoming Scuds. These critics seem to have expected 100% "leakproof" protection and argue that anything less than this was not useful. It seems plausible that USCENTCOM would have been circumspect regarding Patriot effectiveness and capabilities against Iraqi Scud missiles. While this may have been the case internally within the command, it would have been useful to convey an impression to the Iraqis that the Scuds were having no success against their intended targets in an effort to discourage additional Iraqi launches. The achievement of an excellent, though imperfect, intercept capability against the Iraqi Scud threat was of extreme value to those threatened. Israel, with only a few major urban targets, was well served by an imperfect defense. The Gulf War illustrated a type of Third World threat that will become increasingly prevalent. In the near term, this threat will include a limited number of primitive missiles armed with conventional or possibly chemical warheads. This threat will not be of a magnitude that could, in theory, render imperfect defenses useless. Follow-on development and upgrade of the Patriot, or successor system, should be useful in defending against the more sophisticated long-range threats that will be developed in the 1990s and beyond.

And finally, the issue of AF control of Patriot must also be addressed. Careful cost benefit and mission effectiveness analysis is needed. On one hand the AF argues it would have greater control because of its already in place system for airspace management and air defense execution, thereby improving air defense target management. On the other hand, the Army already operates under the C2 of the AF. Control systems in place would be the same regardless of who owns Patriot. The Army also requires responsive systems to defend against an expected air threat when deployed, often without AF assets. An internal Army AD protection system is needed. Furthermore, AF control would require a duplication of effort to replicate already existing Army systems needed for ground elements to operate.

Passive Defense

Overall, passive missile defense measures were employed effectively. As noted, deception played a highly important function. Of all the JTMD pillars, passive defense capability can be achieved for the least amount of dollars spent. Common soldier skills must continue to be trained and leaders must continue to consider and emphasize the doctrinal considerations detailed for this pillar.

Attack Operations

Efforts to destroy Iraqi Scuds during Operations Desert Storm have provided valuable lessons and uncovered apparent shortfalls in overall Army and, in some cases, US capabilities to detect, locate, identify, target, and destroy mobile missiles and systems. The Army did achieve a high degree of success in the area of attack operations through the introduction of the ATACMS system. Increased success of this system will be realized as doctrine is developed and organizational adjustments are formulated. However, the conduct of attack operations against enemy missiles will continue to pose a formidable set of problems for the foreseeable future. In future scenarios, each threat must be analyzed individually when deciding what priority and which assets should be devoted to attack operations. Resources dedicated to Scud hunting and attack, as was done in the Gulf War, may not be available for other missions. In each scenario, a careful trade off analysis will be necessary to determine whether an intensive missile hunt involving dedicated assets is worth the cost to other missions.

During the Gulf War, destruction of missile launchers was not easy to accomplish. The operational and intelligence problems inherent in locating and attacking missile launchers were severe. The Scud missile, which was transported and fired from a highly mobile launcher vehicle, was easy to move from location to location. Iraq gave high priority to the

protection of missile launchers. The redundancy of protected launchers and tunnels made it difficult to determine the location of missiles in storage. Launch locations were relatively easy to find after missile firing; however, the Iraqi doctrine of using preselected firing locations, quickly moving a launcher in and firing and immediately moving to a hide location, greatly impeded counterstrike operations.

To attack launchers TELs have to be distinguished from thousands of other vehicles on the battlefield. Despite the priority given to finding and destroying launchers, it will never be easy to find and destroy them in the time available. Remotely piloted vehicles equipped with cameras can fly continuously above suspected missile storage sites to look for launchers as they move missiles out for firing. However, decoy vehicles, identical in appearance, can be used to fool sensors. Smoke and other screening systems can be used to mask storage facilities from observation. Night transport of missiles limits the ease with which launcher movement can be observed A large number of presurveyed launch sites may make it impossible to monitor all of them.[94] This problem becomes especially acute with longer range missiles, which may be fired at less than their maximum range. The size of the area from which the missile can be fired is likely to be too large to keep under surveillance. Thus, even with modern intelligence collection methods and

sophisticated munitions, it will probably not be possible to detect TELs reliably and attack them in transit. Even if it is possible to locate the launchers, it is still not easy to destroy them. The air strike is often the most likely method of attacking launchers because it is accurate, flexible, and has the range required to attack mobile targets of this type. However, unless the aircraft are overhead at the precise moment a launcher is exposed, the amount of time required for the aircraft to fly to the target area may be too long. This is especially true for long-range missiles. Army capabilities must be more carefully considered as the primary means of destruction.

The proliferation of launchers makes the destruction of any one launcher relatively unimportant. Although destroying launchers limits the number of missiles which can be fired at any one time, so long as some launchers remain it is possible to launch missiles until inventories are totally depleted.[95] Thus, to stop all missile attacks it would be necessary to put every single launcher out of action or destroy all available missiles. Recent experiences and operational feedback should greatly assist intelligence and operational planners in improving targeting strategies against mobile ballistic missile systems. The Desert Storm counter-Scud operation needs to be built on. Improved techniques and equipment for an area analysis will help

improve the Army's ability to predict general mobile Scud operating areas and, in some cases, specific launch sites. While successes occurred, they clearly did not provide a clear-cut solution to targeting problems that Iraqi mobile missiles posed.

C^3I

The experience of trying to locate and target mobile systems has validated the usefulness of several target intelligence support techniques never tested in combat. By the end of the first week of hostilities, it became apparent that the Iraqis were operating from a number of discrete "launch baskets."[96] Continued efforts in these C^3I areas will lead to an improved Army capability to perform the overall mission. Improvements in the Army intelligence architecture might provide somewhat more precise and timely cuing to strike weapon systems. At some point, targeting mobile ballistic missile systems will most likely require an armed reconnaissance mission that relies significantly on tactical sensors to acquire a target in an operating area defined by intelligence. Here again, Army capabilities could be expanded with improvements in technology to have a positive impact on the JTMD mission. The key to successful future operations against relocatable targets appears to be the development of realistic intelligence capabilities to

narrow search areas sufficiently so tactical delivery systems, air or ground, with either organic sensors or nonorganic tactical sensors, can effectively search the area and localize targets. The geographic contraction of mobile Scud operating areas, however, was still not sufficient to allow effective targeting. The Coalition forces' difficulty in completely destroying Iraq's Scud capability in these relatively small areas appears to be the result of inadequate cuing and operationally related sensor shortfalls. National intelligence sensors could not support the requirement to provide precise target coordinates in near-real-time to strike aircraft.[97] Tactical aircraft onboard sensors also apparently failed to discriminate Scud-related targets in the launch baskets, even when tipped off by launch events.

Improvements in intelligence collection and architecture might provide more timely cuing to strike assets, both air and ground, in certain situations. However, the inherently mobile nature of Scud-type targets will probably not support a "fixed target" solution in which precise target coordinates can be passed to strike aircraft. At some point, targeting mobile ballistic missile systems will become an armed reconnaissance mission, which will rely to a significant extent on tactical assets to acquire a target in an operating area that intelligence sensors and assessment methodologies have defined. This is an area where

the Army already has a significant capability. A possible key to successful future operations against this type of target appears to be developing intelligence capabilities to narrow search areas to the point that tactical assets can effectively search the area and localize targets of interest.

General

Some shortfalls brought to light in this thesis point out the need to explore alternate intelligence sources, such as Army special forces reconnaissance operations or positioned sensors. The Desert Storm experience also highlights the need to develop and exercise an adaptive targeting architecture aimed at shortening current target intelligence, mission planning, and force execution timelines.

In general terms, there is one critical area which needs much improvement across all JTMD mission requirements. Both Army and joint doctrine for the C3I mission need to be reevaluated and updated to bring the US on line in support of the role it plays as a world leader. Many innovative systems have been developed that have not been put to test in an actual combat situation. The advancement of technology, linked with the need for joint coordination and communication, make the need for formalized doctrine in this area more important. The lessons learned in Desert Storm

clearly highlight the problems faced in this area. Although there were many successes, the means to accomplish the mission were often ad hoc and constantly changing.

Future Study

One of the stated expectations of this paper was to compile in a single document all relevant information derived from a variety of JTMD experiences and missions. It is hoped that some combination of facts, information, discussion, and analysis presented here can be used to help answer other JTMD issues beyond the scope of this paper. Many lessons learned in Operation Desert Storm provide the framework to develop more effective and realistic approaches to targeting and attacking mobile systems, such as the Scud, in the future. In addition to the judgements provided here, other areas that could be further examined are identified below.

On a global level, the US needs to reevaluate its stance on the Anti-Ballistic Missile Treaty (ABM).[98] The ABM Treaty is an agreement suited to the past which was reasonable at a time when the only serious missile threat to the superpowers came from each other. As the number of countries with ballistic missiles increases, and the severity of the threat expands, the logic supporting the ABM Treaty vanishes. The Gulf War demonstrates that Third World countries pose a ballistic missile threat, and that a treaty

intended to preserve US and former Soviet vulnerability to any long-range land based missile threat is increasingly archaic. Revising the ABM Treaty to permit defense against Third World missiles would be in the best interest of the treaty signatories. In contrast, maintaining the ABM treaty as sacrosanct can only encourage leaders such as Saddam Hussein to pursue ballistic missiles.

More applicable to the military community, specifically the Army, information provided may contribute to further study and actions to help improve TMD capability. The Army could now more closely examine the capability of specific pieces of the matrix, conduct more detailed cost benefit analysis of needed systems, more closely examine other service roles and responsibilities, or begin to improve on identified system capabilities. Regular Joint and Army exercises to improve or maintain needed capability as mentioned could further assist the Army in improving TMD capability.

Closing

JTMD observations and evidence not only demonstrates Army JTMD capability but continues to validate the need for adherence to military leadership and problem solving considerations. The situations and information provided in this thesis also highlights the many challenges faced by

military leaders at all levels. The requirements and considerations needed to maintain and improve JTMD capabilities are, in general, much the same for many of other issues faced today. Decisions on JTMD related issues will have a significant impact on the Army, joint force, and nation as a whole; therefore, it is critical that the issues be given full attention to reach the "best" decision possible. Reliance and application of time proven leadership and decision making theories and doctrine will help provide basic understanding to approach JTMD decisions. The observations and evidence provided in this thesis show that important leader considerations were both overlooked and applied with varying degrees of success or failure. Appropriate consideration may help solve and guide leader decisions.

Leaders at all levels must strive to study, understand and prepare for situations to reduce risks and improve the chance of mission success. Because actions and responses do not occur the same way all the time (i.e., perfect world) we can not completely rely or count on past successes. While command and control is difficult and situation dependent, military history provides many examples where established procedures, detailed planning and training helps to overcome unexpected difficulties, which should be expected. Even though Americans are known for ingenuity, as further

demonstrated by the ad hoc systems developed during the Gulf war, they must develop and train proven systems to improve the chance of success when called on with the least amount of casualties.

Certainly leaders at all levels, have the ability and resources to develop some degree of doctrine, training, leadership, organizational structure, and material systems needed to plan ahead, decrease unacceptable risks and improve the chances of mission success. We must strive to carefully study and decide what combination of resources is needed to realize the largest improvement in capability while balancing factors required for mission success. Some combination of assets is needed to maintain and improve Army JTMD capability. Having a large number of major JTMD related programs developed and several successful systems in place, a great deal of the JTMD mission could continue to be most effectively executed and coordinated by the Army with the least amount of new investments, technology and programming.

ENDNOTES

[1]Quote taken from , Operation Desert Shield/Storm; Theater Missile defense (Ballistic) Lessons Learned Handbook, September 1992, p.8.

[2]Third World missile defense trends were develped from several sources. Most of the threat data and information was gathered were devloped from Seth W. Carus, Ballistic Missiles In The Third World, (Washington DC: Center for Strategic and International Studies) 1990.

[3]Carus, 34.

[4]A majority of the JTMD definitions were pharaphrased from U.S. Armed Forces Joint publications. U.S. Armed Forces, Joint Publication 3-01.5., Joint Theater Missile Defense, was the primary source.

[5]Lawrence Livermore National Lab, International Defenses Against Balistic Missile Attack: Now, More Then Ever, 4 Mar 91. Further development of the need to protect against this missile threat is specified in U.S. Joint Chiefs of Staff. Theater Missile Defense Mission Needs Statement. 18 Jul 91.

[6]Charles E. Kirkpatrick, The Creation of the Antiaircraft Service of the United States Army, 1917-1918; Archie in the A.E.F., (Ft. Bliss Texas: USAADASC, 1984).

[7]The US Army Strategic Defense Command, Joint Theater Missile in Huntsville, AL, provided a history of JTMD terms.

[8]Ibid.

[9]Terms are defined in accordance with U.S. Armed Forces, Joint Publication 1-02, DOD Dictionary of Military and Associated Terms.

[10]CBRS sytem description and definitions were provided by the are TRADOC Program Integration Combined Arms Command, Ft. Leavenworth, KS.

[11]Joint Publication, 3-01.5.

[12]Ibid.

[13]Ibid.

[14]Carus, 48.

[15]Discussion of complimentary JTMD measures are best detaled in U.S. Armed Forces, Joint Publication 3-01.1, Joint Doctrine for the Defense of the United States Against Air Attack.

[16]Ibid.

[17]Ibid.

[18]Joint Publication, 3-01.5.

[19]Ibid.

[20]Paraphrased from U.S. Armed Forces. Joint Publication 3-52. Doctrine for Joint Airspace Control in the Combat Zone.

[21]Ibid.

[22]Discussion Iraq capabilities was summarized from Keith B. Payne, Missile Defense in the 21st Century: Protection Against Limited Threats Including Lessons From The Gulf War, (Westview Press, 1991), pp 35-68.

[23]Ibid.

[24]Ibid.

[25]Ibid.

[26]Descrepencies in the exact number of missiles fired between DOD and independent sources are minimual and still provide a general feel for the nature and conduct of the missile threat. The information used here was summarized from , Mobile Short-Range Ballistic Missile Targeting in Operations Desert Storm, November 1991.

[27]Ibid.

[28]Ibid.

[29]Military Professional Resources, Inc. (MPRI)

[30]Ibid.

[31]William K. Stephens, "Strategic Defense Changes Shift Research", Defense Week, 29 June 1992.

[32]Military Professional Resources, Inc. (MPRI)

[33]US CENTCOM after action reports provided information concerning actions taken prior to the deployment of the headquarters as taken from U.S Depatment of the Army. Desert Shield/Storm After Action Report, Combined Arms Command. July 92.

[34]US Army lesson learned system provides an electronic data base that contains information concerning past operations. Information summarized from this source are taken from U.S. Depatment of the Army, Joint Universal Lessons Learned Systems Reports, on Operation Desert Shield/Storm, Training and Doctrine Command 1991-1993 (252 Reports). Information taken from this source will be identified as JULLS followed by the headquarters the information was reported by.

[35]JULLS; CENTCOM.

[36]JULLS; CENTCOM.

[37]Payne, 132.

[38]As taken from Military Professional Resources, Inc. (MPRI)

[39]Ibid.

[40]Ibid.

[41]Ibid.

[42]Ibid.

[43]John F. Hamiliton, "Pentagon Presents Missile Defense Plan", Defense Week, 13 July 1992.

[44]Payne 135.

[45]JULLS; USAADASCH.

[46]Ibid.

[47]Ibid.

[48]Ibid.

[49]Discussion of Patriot PEO concerns was provided by the HQ US Army Missile Command, Redstone Arsenal, AL, Project Management Office.

[50]JULLS; USAADASCH.

[51]Ibid.

[52]Information pertaing to Fratricide plan was provided by Training and Doctrine Command (TRADOC) Headquarters, Fort Monroe, Virginia. The Army fratricide prevention plan, as developed by TRADOC, identifies doctrine, training, leadership, organizational and material solutions to fix identified defficiencies.

[53]AirLand Force Application Agency (ALFA), Langley AFB, VA and HQ Department of the Air Force (XOXCR), Washington, DC.

[54]Ibid.

[55]Ibid.

[56]Ibid.

[57]Military Professional Resources, Inc. (MPRI).

[58]J.W.Schomisch, J.W. JFACC: Command and Control What Army Air Defense Commanders Need to Know, Carlisle PA: Army War College, 1991.

[59]U.S. Defense Intelligence Activity.

[60]Ibid.

[61]Ibid.

[62]TRADOC.

[63]JULLS; USAADASCH.

[64]ALFA.

[65]Summarized from CAC Desert Shield/Storm Lessons Learned.

[66]JULLS; CHEM SCHOOL.

[67]JULLS; CENTCOM.

[68]JULLS; CENTCOM.

[69]MPRI, 1-13.

[70]MPRI, 1-15.

[71]MPRI, 2-12.

[72]Summarized from Payne, 56.

[73]JULLS; CENTCOM.

[74]Discussion of difficulties experienced in joint communication was identified by several sources. Most detail was provided by JULLS reports from CENTCOM.

[75]U.S. Armed Forces, Joint Publication 3-01.2. Joint Doctrine for Theater Counterair Operations.

[76]MPRI, 2-22.

[77]MPRI, 4-23.

[78]TRADOC Headquarters.

[79]JULLS; CENTCOM.

[80]ALFA.

[81]JULLS; USADASCH.

[82]Ibid.

[83]Ibid.

[84]ALFA.

[85]Ibid.

[86]Ibid.

[87]John Daley "High altitiude Theater Missile Defense." Aerospace Daily, 1991 p 23-26.

[88]Discussion of Army Mohawk capabilities was given by the US Army Aviation Center and School, USAAVSCH, Ft. Rucker AL.

[89]This discussion of intelligence and BDA difficullties was given by the US Army Intelligence Center and School, Fort Huachuca Arizona.

[90]Ibid.

[91] Thomas E. Salerno, "Joint Chiefs to define Missile Defense Roles." Defense News, 23 Dec. 1991: 4-18.

[92] Ibid.

[93] Discussion of Patriot critics was summarized from MPRI, 4-23-34.

[94] Discussion of difficuly in finding launchers taken from Edward J. Walsh, "Navy Moves to Counter Ballistic Missiles." Sea Power, 1992: 39-44.

[95] Ibid 43

[96] MPRI, 5-34.

[97] As provided through conversation with the by the Defense Intelligence Agency, Bolling AFB.

JTMD SOURCES OF INFORMATION

Commands and Activities.

Commands and activities consulted during the course of this research are listed below. A wealth of data and information was gathered from these program offices and used in this thesis. Command briefings and direct contact with project officers and managers from these agencies account for a great deal of the background and evidence provided.

ACTIVITY	ADDRESS
AirLand Force Application Agency	Langley AFB, VA
Combined Arms Command, TRADOC Program Integration Office - *Deception*	Ft. Leavenworth, KS 66027-5300
Combined Arms Command - Center for Army Lessons Learned	Ft. Leavenworth, KS 66027
DA Army Special Projects Office, TENCAP Project Office	2810 Old Lee Highway Fairfax, VA 22031-4304
DA Program Executive Office - Intelligence and Electronic Warfare	Bldg P-181 Vint Hill Farms Sta. Warrenton, VA 22186
Defense Intelligence Agency, Relocatable Target Section, DB-8C	Bolling AFB Washington, DC 20340
HQ Department of the Air Force (XOXCR)	Washington, DC 20330
HQ US Army Missile and Space Intelligence Center AIMS-TS	Redstone Arsenal, AL 35898-5500
HQ US Army Missile Command, PEO Fire Support SFAE-FS-I	Redstone Arsenal, AL 35898-8000

HQ US Army Missile Command Project Management Office - ATACMS	Redstone Arsenal, AL 35898
HQDA, ODCSOPS, DAMO-FDE	Washington, DC 20330
HQ, Strategic Defense Command, CSSD-IN	Arlington, VA 22215-0280
HQ Tactical Air Command/ DR SMO-J	Langley AFB, VA 23665-5001
JFK Special Warfare Center, Lessons Learned Team	Ft. Bragg, NC
Office of the Joint Chiefs of Staff, Joint Oversight Steering Committee, J7	Washington, DC 20330
Office of the Joint Chiefs of Staff, J-36	Washington, DC 20330
Strategic Defense Initiatives Office	The Pentagon Washington, DC 20330
US Army Air Defense School, Combined Arms and Tactics Department	Ft. Bliss, TX 79916
US Army Air Defense School, Directorate of Combat Developments	Ft. Bliss, TX 79916
US Army Air Defense School, Directorate of Combat Developments, C^2 Division	Ft. Bliss, TX 79916
US Army Air Defense School, Directorate of Training Development, Patriot Training Development Division	Ft. Bliss, TX 79916
US Army Air Defense School, Library	Ft. Bliss, TX 79916
US Army Engineer School, ATSE-CDC	Ft. Leonard Wood, MO 65473-6620
US Army Field Artillery School, Systems Manager Office, Combat Systems Instruction Department	Ft. Sill, OK 73503

US Army Intelligence and Electronic Warfare School, TRADOC System Manager, Unmanned Aerial Vehicle	Ft. Huachuca, AZ 85613-6000
US Army Missile Command - Program Executive Office Air Defense, SFAE-AE-AD	Redstone Arsenal, AL 35898-5750
US Army Strategic Defense Command, Joint Theater Missile Defense Program Office, Concepts and Integration Office, CSSD-TM	PO Box 1500 Huntsville, AL 35807
US Army Strategic Defense Command, SI/BM/C^3I Division, CSSD-TM-S	PO Box 1500 Huntsville, AL 35807
US Army Signal Center, Directorate of Operations and Evaluations Systems	Ft. Gordon, GA 30905
US Army Space Command	1670 Newport Rd Colorado Springs, CO 80916
US Army Space Institute	Ft. Leavenworth, KS 66027
US Central Command, Office of the Scientific Advisor to the CINC	MacDill AFB Tampa, FL
US Space Command - SPJ3MM	Stop 35 Peterson AFB, CO 80914-5000
11th Air Defense Brigade	Ft. Bliss, TX 79916
11th Air Defense Brigade 13th Ordnance Company	Ft. Bliss, TX 79916

Joint Universal Lessons Learned (JULLS).

The JULLS systems provided many of the observations identified in chapter four. JULLS is an electronic database search and retrieval system. It attempts to capture all pertinent joint issues in a electronic data base contained on

a PC computer hard disk. The data base contains approximately 6000 subjective evaluations of joint level lessons learned from FTXs and operations. Portions of the data base are classified and all of it is non-attributable. Other sources of information; books, articles, publications and reports are listed in the bibliography.

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Aerospace Daily, 28 August 1991.

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U.S. Armed Forces. Joint Publication 0-1. Doctrine for Basic National Defense.

U.S. Armed Forces. Joint Publication 0-2. Unified Action Armed Forces.

U.S. Armed Forces. Joint Publication 1-01. Joint Publication System.

U.S. Armed Forces. Joint Publication 1-02. DOD Dictionary of Military and Associated Terms.

U.S. Armed Forces. Joint Publication 3-0. Doctrine for Unified and Joint Operations.

U.S. Armed Forces. Joint Publication 3-01.1. Joint Doctrine for the Defense of the United States Against Air Attack.

U.S. Armed Forces. Joint Publication 3-01.2. Joint Doctrine for Theater Counterair Operations.

U.S. Armed Forces. Joint Publication 3-09. Doctrine for Joint Fire Support.

U.S. Armed Forces. Joint Publication 3-52. Doctrine for Joint Airspace Control in the Combat Zone.

U.S. Armed Forces. Joint Publication 3-55. Doctrine for Joint Reconnaissance, Surveillance, and Target Acquisition.

U.S. Department of the Army. Field Manual 100-5. Operations.

U.S. Naval Warfare Publication 10-1. Composite Warfare Commander's Manual."

U.S. Naval Warfare Publication 10-1-21. Antiair Warfare Commanders Manual.

U.S. Naval Warfare Publication 32. Antiair Warfare.

U.S. Air Force Manual 1-1. Basic Aerospace Doctrine.

U.S. Marine Corps Operational Handbook 5-8. Control of

Aircraft and Missiles.

U.S. Fleet Marine Force Manual 5-60. Control of Aircraft and Missiles.

U.S. Depatment of the Army. Chief of Staff, Joint Tactical Missile Defense Master Plan. 20 Jul 89.

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